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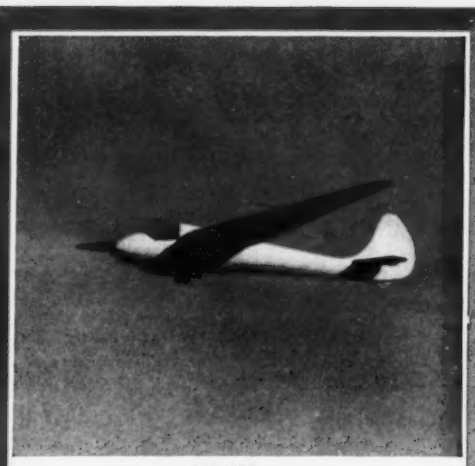

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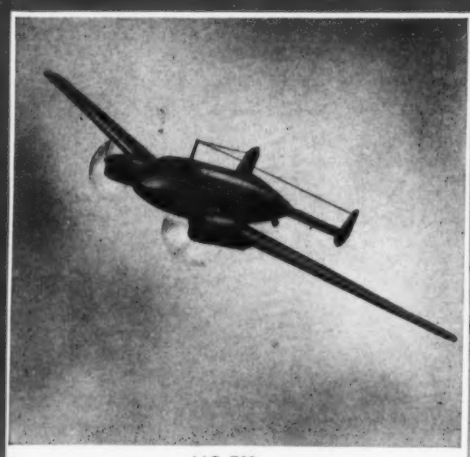

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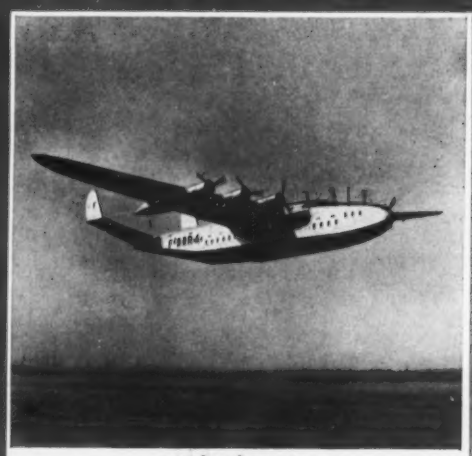

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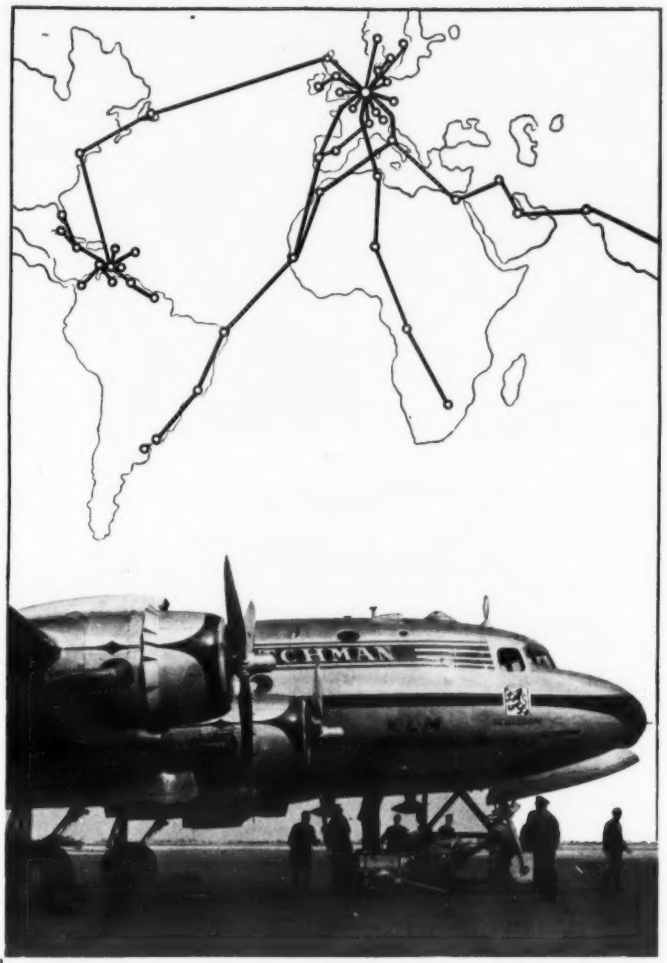

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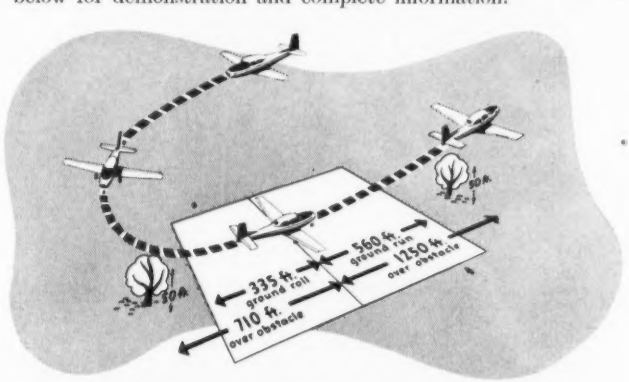

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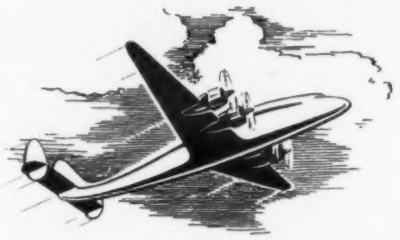

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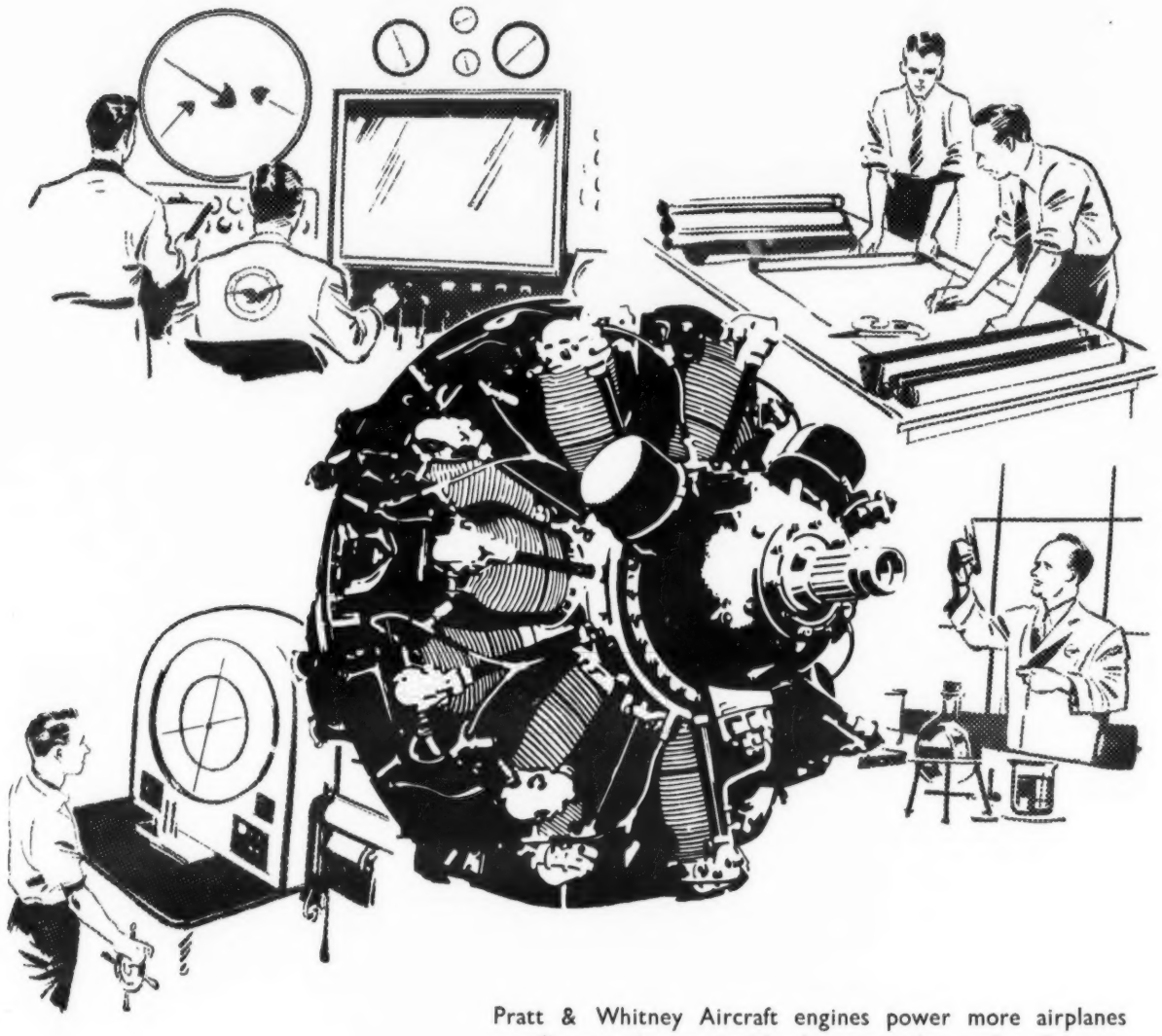

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Marginal Notes

7th June, 1948

Marshall Plan and Aviation

It is now a year ago since the World first heard of the Marshall Plan. On June 5th, 1947, Secretary of the State Department George C. Marshall addressed a gathering at Harvard University and made public his ideas for a generous aid towards the economic reconstruction of Europe.

And likewise almost twelve months after this first declaration, the House Appropriations Committee brushed aside the recommendations of the European Recovery Program (E.R.P.) — the new name for the Marshall Plan — and demanded a reduction of about twenty-five per cent. in the $6,800,000,000 foreseen for the first fifteen months (April, 1948 to July, 1949). Whether the remaining sum seems great or small to the layman is beside the point. The European countries favoured by E.R.P. have worked out their budgets on the basis of the promised aid, and it is understandable that such a reduction would entail some drastic revisions on the part of all Governments affected. With respect to Great Britain, for instance — Marshall favourite No. 1 — this twenty-five per cent. denotes the princely sum of $330,000,000. To have or not to have ?

So much for the general aspects of E.R.P., which is to start this summer, covering among other things the delivery of food, machines, steel and iron, coal and oil, chemical products and transport vehicles.

And aviation ? Does the Marshall Plan disregard aviation altogether ? Don't make any mistake about it. It will affect aviation very considerably, not only because aviation, as such, is the youngest and most sensitive branch of commerce, but also, and most of all, because it is a branch of commerce which at present concerns wide circles in America.

A silent condition to the application of the European Recovery Program has, of course, always been that its effects should not be detrimental to the giver, thus to the American taxpayer, and that the money should be used rationally. You might ask how it could be used to the detriment of the giver. For instance, if E.R.P. unwittingly fostered undesirable European competition, which could give rise to complaints against the law maker, thus the American Government. And rational utilisation ? In no circumstance should it favour nationalisation or socialisation of economy, a trend which is shunned in the U.S.A., cultivated in Eastern Europe, dangled before the eyes of the French, and still courted by the Labour Government in Great Britain.

Expressed simply, it means that the Americans desire to help Europe in those fields which are of vital importance to European economy. If it concerns fields which only border European interests, but perhaps affect American economy itself, then there is to be no aid.

This brings us to the practical side, to aviation. From the already extensive information promulgated on the Marshall Plan, only three distinct items may be said to concern aviation in any great measure :

The Italian Government succeeded in its request that E.R.P. supplies for the first of the four years of the Marshall Plan should include aircraft, engines and spare parts in a total amount of $2,500,000. This concerns items of which there is a shortage in Italian aviation, it does not concern gigantic sums, and it is by no means said that, aside from this, Italy will not also acquire military or civilian aircraft from U.S. surplus stocks.

Another case : The Deputy Chairman of British Overseas Airways Corporation, Sir Miles Thomas, indicated during a recent visit to the U.S. West Coast that dollars might be made available for the purchase of American airliners by the British airline corporations. This sharp change in Britain's hitherto " Fly British " procurement policy, a courageous plan to place British civil aviation on a sound economic basis, has not yet been confirmed officially. If, however, dollars are ultimately made available, then they could of course only come out of the Marshall Plan, and would have to be utilised according to the conditions of the Plan.

A third example : Bills providing for Federal Government promotion of new designs for commercial transport aircraft which in an emergency could be used for auxiliary military purposes through rapid modification, have been introduced in Congress by Senator Owen Brewster and Representative Carl Hinshaw. The assumption is that " in the foreseeable future " the U.S. aircraft industry will be unable to bear the cost, ranging from $20 million to $50 million in each case, of developing advanced transport aircraft — indispensable for national defence and international prestige — without the Government's financial aid. During the hearings on the Bills, the Marshall Plan came unexpectedly on the carpet. Brewster attacked the U.S. Government for creating a " grotesque situation " by spending milliards of dollars to aid friendly nations who then turned this aid into a " farce " by using part of it to build up airlines competing with U.S. carriers. The U.S.A. should work out plans with Britain, France and other countries to share the development of transport aircraft and abolish competitive air transportation.

Can you really blame the Yankees ? After all, they read in British papers that the British themselves are doubtful about the wisdom of spending around $45 million on the Bristol " Brabazon I " giant airliner, for instance, and that British aviation circles are still unable to say definitely when and how this aircraft will fly. But the Americans are all the same asked to supply raw materials and ready cash, whilst all the time their own industry is distinctly in the red. Firms like Douglas, Boeing, Lockheed and Convair are still not able to balance the accounts relative to their transport aircraft. The executives of these firms might one day get it into their heads to storm Washington, if they ever thought that the U.S. Government was spoiling their field. After all, they are the taxpayers, and it is from their pockets that the Marshall money has to come.

It is evident, therefore, that the effects of the Marshall Plan could eventually promote the U.S. aircraft manufacturers' export trade. If some of the countries concerned have well-equipped aircraft industries of their own, then one might imagine this export trade extending to licence production rights for proven aircraft. The idea would be perfectly sound. It would at least be one way of avoiding adventures and uneconomic experiments, and it might perhaps lead — at least as regards large airliners — to some kind of standardisation. The aircraft industry of war-weakened Europe could find nothing but strength from Marshall aid of this sort, and one day — freely and independently — might be able to build up an exemplary production of her own.

But because a number of Chauvinists may not be entirely in agreement with such ideas, and perhaps have not even had a chance of studying the basic principles put forward by the European Cooperation Administration — the European aid organisation at present headed by the industrialist, Paul G. Hoffmann — we shall conclude by explaining the fundamental principle of the Marshall Plan by means of a simple anecdote :

In the Russian sector of Berlin passengers were having their papers examined as usual. A Russian soldier approached a man, who pulled out his wallet containing his identity papers. Inside the wallet, a thick bundle of thousand-mark notes caught the Russian's eye. He immediately put it into his own pocket and said, " You — too much ! " Later he came to an old lady, and noticed that she had only a very few marks in her purse. Taking out the fat bundle of thousand-mark notes from his pocket, he handed it to the old lady, saying, " You — too little ! "

There you have the Marshall Plan in miniature.

EEH.

On the Way to All-Weather Flying

THE RTCA PROGRAMME

Civil aviation today stands at a turning point. Not because new flying equipment is in immediate prospect, or because any revolutionary invention in aeronautics is indicating a new developmental trend. It has just simply reached a point where new aircraft, perhaps through well-thought-out detail improvements, can reduce the operating costs by a fractional percentage or shorten the actual flying time over a route by a few minutes—though this can nevertheless entail no change in the general situation. The purchase prices of new aircraft will continue to rise, increasing demands will be placed on ground personnel and flight crews, and all this will come to light again in the annual financial results of the scheduled airlines.

Scheduled flying ! When, a few years ago, this expression was coined in order to distinguish regular airlines flying according to predetermined timetables from charter companies, it was not thought that, one day, the word "scheduled" would be the key to the being or not-being of profitable civil air transport. Let us take the U.S. airline companies as example. At the end of 1947 they reported a total loss of $22 million for the year's operations. This fact, unpleasant as it may be, and even surprising for persons not acquainted with air transport questions, has given rise to lively public discussions in the past months. Not so well known, meanwhile, is that in 1946 American airline companies lost in actual and potential revenue nearly $40 million because of bad weather, thus because of cancellations, low load factors resulting from unreliability, and congestion at stations. This sum also includes the expenses arising from interrupting or re-routing services, when the airlines have to pay for passengers' accommodation and supplementary transportation.

It is therefore evident that, still today, despite all our navigational aids, instruments, radio equipment, and so forth, weather is the main factor in civil aviation ; and there is evidence to show that this factor has succeeded in turning a highly-developed branch of transport from an economically-productive organisation into a commercial loss. Because over half of the afore-mentioned $40 million are attributable to congestion at airports and excessive burdening of traffic-control and navigation stations—a system which is now operated by the U.S. Civil Aeronautics Administration at an annual cost of nearly $39 million—the U.S. professional association, the *Radio Technical Commission for Aeronautics*, undertook at the beginning of this year a critical study of the situation and simultaneously worked out recommendations for the safe control of expanding air traffic. The RTCA is a cooperative association of all U.S. Government-Industry aeronautical telecommunication agencies. It conducts studies of aeronautical telecommunication problems, and its objective is the resolution of such problems by mutual agreement of its member agencies.

It is certainly not by pure chance that the RTCA report's publication almost coincided with that of the Presidential Air Policy Commission's ("Survival in the Air Age") and Congressional Aviation Policy Board's ("National Aviation Policy") reports, which both appeared last Spring and represented the cornerstone of extensive U.S. armament in the air. Understandably, anything which today results in unfavourable financial results for civil aviation, can entail much more serious consequences in the event of war. Aeronautics has reached a stage where it would be pointless to organise different operations of aircraft in accordance with their specific purposes. Just as at the beginning of the last war, certain countries were able to put into service a valuable and immediately-available arm by making use of the flying equipment of the airlines, the ground organisation in every aeronautically well-organised country must at all times be ready for smooth conversion to wartime conditions. However, this is only possible if a basic condition is fulfilled : the ground organisation, meaning the entire national radio, navigational and airway traffic control system, must even in peacetime be simultaneously available to the airlines and the air force, and be used by both. "Fine-weather air forces" are next best to no air force at all ; and once war has broken out it is too late to start changing methods and organising new training schemes.

With this in mind, the RTCA makes the following demands of a satisfactory control system :

1. *Safety :* The safe operation of all aircraft requires that adequate separation of aircraft be maintained at all times and under all conditions.

2. *Expeditiousness :* The expeditious movement of aircraft requires airspace utilisation under all conditions equal to that under VFR conditions.

3. *Reliability :* The system shall, as far as possible, be independent of weather conditions and equipment breakdown.

4. *All Aircraft Use :* The system shall be usable by all types of aircraft in a manner compatible with their performance characteristics and operational applications.

5. *All Weather :* The system shall function effectively during all weather conditions.

6. *All Airspace :* The system shall be capable of expansion to include all usable airspace.

7. *Minimum Control :* The system shall provide control that imposes a minimum of restriction on the movement of the aircraft.

8. *Integration :* The elements of the system shall be integrated.

9. *Human Factors :* The system shall impose a minimum burden on such human factors as competency, training, and alertness of air and ground personnel.

10. *Evolution :* The system shall permit orderly transition from the utilisation of established air traffic control aids to those ultimately required.

11. *Flexibility :* The system shall incorporate characteristics which make practicable the handling of a wide variety of operational situations.

12. *Security :* The system shall be designed with due consideration for system security in the interest of national defence.

13. *Limitation of Traffic Flow :* The system, in itself, shall not limit traffic flow below the acceptance rate of the airports.

14. *Language Difficulties:* The system shall operate independently of the language capabilities of ground and airborne personnel.

15. *Identification:* The system shall provide a means of identifying aircraft as required for purposes of traffic control and in the interest of national security.

16. *Division of Responsibility:* The Traffic Control Agency shall be responsible for Air Traffic Control planning, the collection of pertinent information, and the dissemination of traffic clearances and information.

The pilot shall be responsible for compliance with the control agency's clearances, subject to a primary responsibility for the safe conduct of the flight. The appropriate regulatory authority shall promulgate rules and regulations required for the proper functioning of the Air Traffic Control System.

17. *Division of Equipment:* The system shall place the primary burden of weight, volume, and physical complexity of equipment on the ground. The aircraft equipments shall result in the minimum detriment to aircraft performance.

18. *Frequency:* The frequency allocations for the system shall be consistent with National and International Tables of Frequency Allocations.

19. *Cost:* The cost of the system shall be compatible with the results obtained.

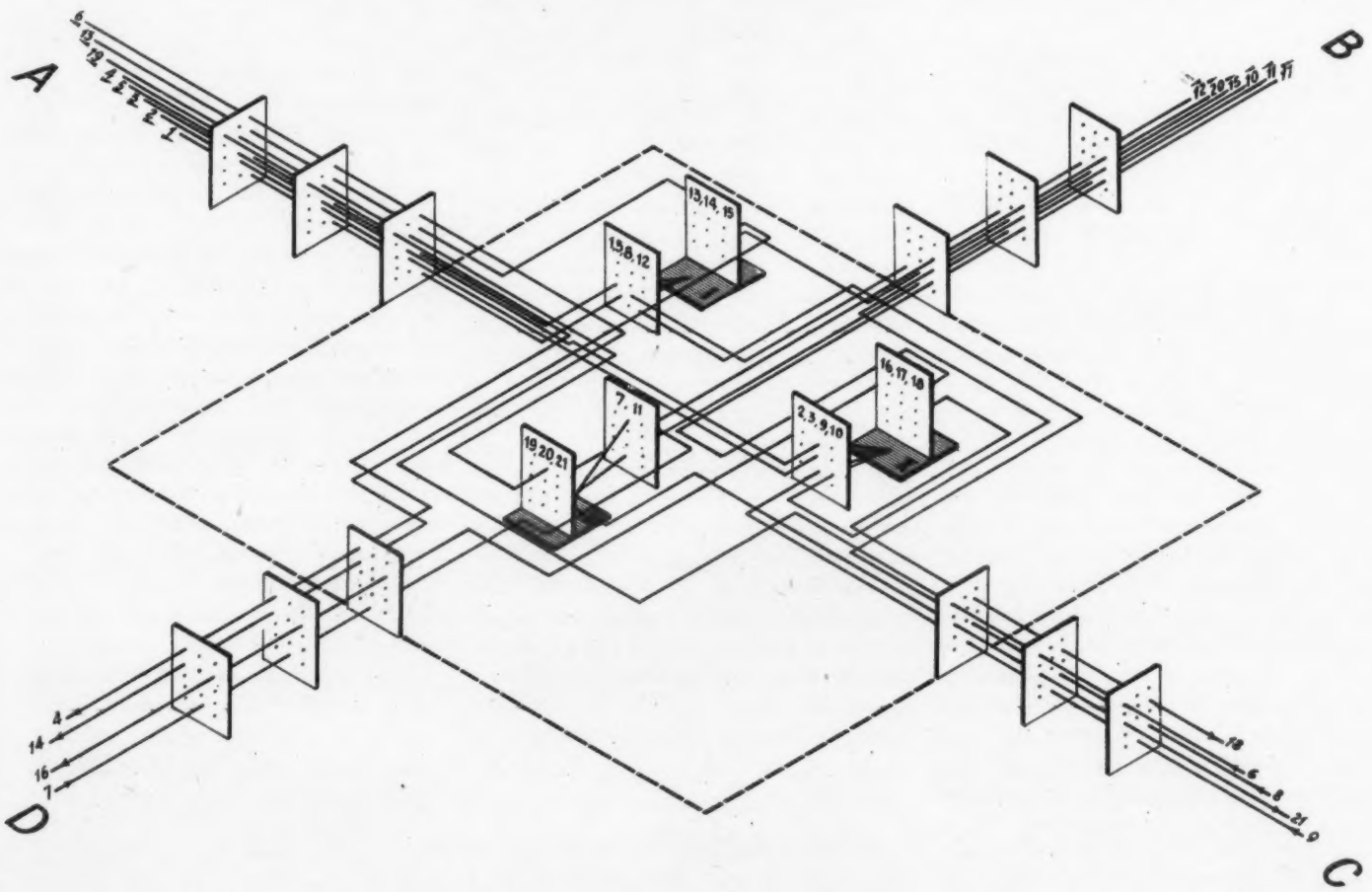
The plan to create such an extensively automatised air traffic control system signifies a tremendous step forward and represents the first instance in aeronautical history where provision is made for the complete consolidation of national defence and civil aviation requirements. It is estimated—somewhat optimistically — that fifteen years will be required for the complete development; the first five years are to constitute an interim period.

The interim programme is regarded as an urgent necessity, since the present situation of civil aviation is revealing those difficulties which the air force would encounter under unforeseen, exceptional circumstances. It is therefore to be commenced immediately, and completed within a five-year period. In the main it is to comprise: equipment of all aircraft—including personal aircraft—with lightweight VHF receivers to permit use of static-free voice channels and omni-directional range navigation; supplementation of the ground organisation by installing ILS and GCA equipment; development of distance-measuring equipment and course computers, as well as the completion of a radar cover of the more crowded traffic areas and the installation of airborne transponders in all aircraft capable of planned instrument flight. The RTCA Programme utilises the existing air navigation and traffic control facilities in the interim period.

Although the VHF automatic direction finder cannot be integrated into the final RTCA system, its installation at airports is recommended for the interim period, as well as a simple mechanical interlock board, to assist harassed traffic controllers and tower operators.

Most of the equipment for the interim period is now ready for use, or at least in the test stage, so that only two per cent. of the cost of the interim programme ($375.2 million) are to be spent on completing its development.

The RTCA has taken pains to work out a comparison of the complete requirements for air traffic control and navigation using both available and proposed facilities; this shows: present facilities provide a factor of merit of 42 per cent., which means that they can scarcely accomplish half of their task; the



The schematic presentation, taken from the RTCA Detail Operational Plan, shows three airports, I, II and III, situated within the same terminal area, which are attainable via four different airways. Indicated are the lanes taken by several aircraft, which, for the sake of clarity, are numbered. *Departing aircraft:* 13, 14, 15 (from airport I); 16, 17, 18 (from airport II); 19, 20 (from airport III). *Arriving aircraft:* 1, 5, 8, 12 (at airport I); 2, 3, 9, 10 (at airport II); 7, 11 (at airport III). *En route aircraft:* 4, 6. At regular intervals along the airways are reference planes; at these points data on speed, course, altitude, etc., are automatically compared with the pre-established flight plans, and each pilot automatically receives flight directions for the subsequent section. In a similar manner, the airports take over control of the aircraft as soon as these arrive in the specific areas. Two reference planes are indicated for each airport, one for arriving and one for departing aircraft.

facilities of the five-year interim programme will step this factor of merit up to 67 per cent. ; and full implementation of the target system, estimated for 1963, will provide a factor of merit of 95 per cent.

The cost of the total system, presupposing normal price trends, is estimated at $1,113 million. Of this total, the greater part, namely $897 million, is required for national defence, *i.e.* ground equipment and military airborne equipment. Requisite airborne installations are estimated at $216 million. Included in the total cost are $75.4 million for the development of equipment needed in the target system but which does not exist at present.

An extensive automatisation such as that projected by the RTCA calls for a distinct division of the air space according to the requirements of Air Traffic Control and Navigation. In addition to the Airway Areas, which comprise that part of the navigable air space over published routes with defined boundaries, are to be the Terminal Areas, each featuring a radius of about 30 miles and an estimated altitude of 7,000 feet. They will comprise the Final Approach and Live Runway Areas. This last area will extend from two to ten miles from the end of the runway, be about two miles wide, and have an upper limit of 1,000 feet above the glide slope. A terminal area may contain one or more airports.

For purposes of traffic control, the navigable air space is to be divided into General Control Areas, representing sections of air space in a mosaic pattern over the entire country and governing all areas except the airport control areas. The airports themselves will only be concerned with organising aircraft arrivals and departures.

Aligned with this division between traffic control and navigation is the projected equipment of aircraft and ground stations. As regards *Aircraft Equipment,* the basic idea is that it should be as light and compact as possible. The Traffic Control Unit, for instance, should not occupy more than 16 sq.in. of the cockpit instrument panel ; it will include a radar beacon which, upon interrogation, will give the aircraft's range, bearing, altitude and identity to ground radar stations. Besides this, the traffic control unit is to include a Private Line Visual Communication System, enabling the pilot to obtain, continuously, intelligence from the automatic ground traffic station control. The Navigation Unit will provide : distance and bearing information for navigation (allowing the pilot to fly any desired course when used in conjunction with a computer) ; glide path, localiser and distance information for ILS approaches ; pictorial cockpit display of neighbouring aircraft, holding patterns, runway obstacles, etc ; and facilities for automatic flight control. All airborne equipment should not exceed 115 lbs. in weight.

Ground Equipment is to be considerably more elaborate. Traffic Data Relay Equipment will comprise two elements : secondary radar to interrogate aircraft radar equipment and receive altitude, bearing and distance intelligence continuously, and identification periodically, from all aircraft in flight ; and private line visual communications, a transmitter-receiver which, connected with the airborne visual communication equipment, will provide the air-ground link for all traffic control intelligence.

Automatic Air Traffic Control Equipment will comprise six elements : (1) Airspace separation equipment, which will analyse fixed airspace occupancy data automatically, presenting for transmission to aircraft (over the private line) the necessary separation of signals ; (2) flow control equipment, receiving position and identity reports and comparing these data with previously created flight paths to establish the sequence of movement of aircraft for expeditious traffic flow, and using the airspace separation equipment for transmission in order to assure that unsafe clearances are not issued ; (3) flight path planning equipment, establishing on the basis of flight plan data received, flight paths to handle traffic in the most efficient pattern ; (4) airport time utilisation equipment, assuring maximum utilisation of runways by assigning specific landing and take-off times ; (5) detail flow control display, giving at any time symbolic and pictorial displays of any portions of the approach area, simultaneously indicating position, altitude, approximate bearing of ground track, and identity of aircraft in the area ; (6) general planning display, furnishing symbolic intelligence on all aircraft arriving or departing from airports within the general control area.

Nav-Aid Equipment will represent an important aid to navigation. It will provide aircraft with their bearing and distance relative to the station, as well as static-free VHF voice communications.

Landing Navigation Equipment will provide aircraft with their lateral deviation from the runway centre-line, their vertical deviation from the glide slope, and their distance from the touchdown point. It will have VHF voice communication, and will transmit to the airborne screen the situation display of the airport, showing obstacles, taxiing or stationary aircraft, etc. It will also provide indications by which GCA landings may be made.

* * *

The RTCA Programme is revolutionary in more ways than one. Such automatisation of airway and airport control, beginning with the co-ordination of the flight plan, the attribution of pre-determined landing times, the accurate holding of a specific position within the traffic flow plan along an airway, up to the automatic transmission of instructions to pilots, will demand a fair amount of skill on the part of flight personnel. The new difficulties ahead will not be comparable with those encountered by many pilots when GCA was introduced ; the RTCA system will cut down the human element in a far greater measure.

Since the projected system is simultaneously to serve civilian and military purposes, the need arises for consolidating the entire ground organisation at one single point (for example, in view of the military need to control aircraft from an island, from a carrier, or from a small strip of beach, all without co-operation of any distant station). This requirement immediately eliminates consideration of all hyperbolic systems of navigation, and likewise of all landing systems requiring equipment placed a considerable distance from the airport. It therefore focuses attention on systems using polar coordinates, which give the position of an aircraft by measurement of its direction and distance relative to the ground transmitter. Omni-range and DME beacons will signify the first step in this direction.

Once it has been completed, the RTCA System in the U.S.A. will comprise 550 ground stations fitted with search radar, traffic data relay equipment, safety separation equipment, and Nav-Aid ; 550 airport control areas ; and 50 general control areas, each of the latter having a general planning unit and a detail flow control unit.

The system will be capable of coping with 100,000 aircraft, made up of 10,000 commercial transports, 35,000 military planes, and 55,000 personal aircraft.

The main difficulties which will confront the realisation of this extremely complex plan are likely to concern above all the development of the equipment which, by means of pictorial transmission and automatic traffic signals, should relieve the presently overcrowded voice communication channels and likewise take care that the inter-connections of the separate elements should automatically make impossible any danger to aircraft. Without such security measures, which, for instance would have to be applied immediately in the case of incorrect piloting, the RTCA System could never attain its goal.

At all events, this programme, in its generosity and lack of compromise, certainly exceeds by far anything hitherto planned or achieved in air traffic control of military or civilian air operations. The application of this programme, however, will not only encounter technical difficulties, but also obstacles of an administrative nature. Within the next decade, meanwhile, the success of the RTCA Programme will be able to show whether the aircraft—as a means of transportation and as a weapon—will remain an individual instrument or be subjected entirely to State control. *Bi.*

"How to torque propeller" ภาษาไม่ปกติ

Linguistic Snags in Aviation

AND GRAVESEND IT WAS !

The following anecdote, related to us by the Danish DDL airline, smacks rather of salt and sails than of airways and propellers. It tells of the good old days before the War, when Danish air captains resembled more their sea-going Viking ancestors than anything else. They knew their stuff, but with foreign tongues they were sometimes more at sea than they cared to admit. A typical example — *nominae odiosae sunt* — was the pilot of the first aircraft to fly DDL's extension to London of the Copenhagen—Amsterdam route. Bad weather in those days had much the same effects as it has today, and eventually he found himself at Gravesend. From Croydon, his correct terminal, came a telegram for him. On it were the laconic words, "Remain at Gravesend." The rugged captain was surrounded by people anxiously scanning his sombre brow for his decision. He on his part did not like to admit that the cryptic message failed to convey any sense to him. But he was up to the situation. With scorn on his face he hurled down the hateful slip of paper and exclaimed determinedly, "Doggone, I won't be bullied. I'm staying right here."

* * *

The modern airline pilot would reach precisely the same decision — though on the basis of his linguistic abilities. For today there is hardly to be found a flight crew member who, in addition to his or her mother tongue, cannot also speak English. Many are capable of conversing in a second or even a third foreign language. But English has become the language of international civil aviation, thereby upholding its old tradition as the international tongue of the seafarers.

Then, you might say, if airline captains, flight engineers, navigators and air hostesses all speak English, why start talking about "linguistic snags in aviation." Unfortunately, however, there are to be found Babel towers within Babel towers. Listen, for example, to the innocent story of the young and beautiful Russian countess who had sought refuge in Prague from the Revolution in her country. In Czech the word "*Pozor*" means "Take Care," and is consequently displayed at every hazardous street corner of Prague. In Russian, however, the same word means "Shame on you!" Whether the blushing countess hurriedly made certain that she had not left her diary lying about for prying eyes, is not known for sure. The story only says she blushed.

It might be going a little far to suppose that linguistic snags in aviation could give rise to such degrees of embarrassment. But there is no dearth of possibilities for misunderstandings between crews and passengers, even if all speak English fluently.

WHICH "ENGLISH" DO YOU SPEAK ?

Oscar Wilde summed up his American tour in his usual superficial, witty manner. "The English," he said, "have really everything in common with the Americans — except, of course, language." Though it might be doubted today whether even the true Irish contempt for money matters of this English "professor of aesthetics" could have remained altogether oblivious to the "dollar problem," cinema-goers are all the same forced to admit that this flippancy was and still is not without some depth. And this is evidently the opinion of that eminent U. S. philologist, H. L. Mencken, whose "The American Language," a volume of some 500 pages, has been decorating the world's library shelves since 1922. He reveals conclusively that the matter does not stop at "American English," or better said, "American." Mencken lists no less than eleven non-English dialects widely spoken in the U.S.A.: American-German, French, Spanish, Yiddish ("die boys mit die meidlach haben a good time"), Italian, Dano-Norwegian, Swedish, Dutch, Icelandic, Greek, and the Slavic languages ... To these means of making oneself understood, or misunderstood, in the U.S.A. may be added many Indian, Chinese... Bronx and Brooklyn words or expressions.

Notwithstanding the confusion which could perhaps arise from the varying pronunciations, on the whole the differences between "insular" English and American English are not likely to produce catastrophic results. Because the American keeps his trousers up with suspenders and his socks with garters, whilst the Englishman uses suspenders for the relatively harmless purpose of holding up his socks, but wouldn't dream of entrusting his main leg adornments to anything less than braces, there need be no fear of scandal. Of course, the American tycoon who ventures to import a true-blood Jeeves to improve his social standing would have to expect an occasional snub. More serious in this respect might be the outcome of a fire outbreak on a second floor in America. An Englishman would direct the firemen to what he calls the first floor, or the floor immediately above the American's first floor which is the Englishman's ground floor ... and by the time the Americans had "gotten" the hang of the situation, the Englishman would have "got" away.

Which reminds us that we had better get back to something sensible; and we couldn't choose a better field than aeronautics. There is quite a list of different terms meaning the same thing — landing gear and undercarriage, airplane and aeroplane, airfoil and aerofoil, propeller and airscrew — but there is little doubt that the War has made them known on both sides of the Atlantic.

But air force slang changes the picture completely. What flyers managed to accomplish in the linguistic field seems to defy all logical explanation. Less well known than R.A.F. and U.S.A.A.F. slang of the last war is perhaps that of the Royal Australian Air Force.

What Mencken is for the American language, Sidney J. Baker is for the "Australian Langu-

age." His philological exploits are no less impressive. Among the 425 pages of his book may be found some truly amazing modes of speed which the inhabitants of "down-under" have managed to evolve from what "Time" magazine (7.8.39) called "that old goat, the English language." And the most fertile source of incomprehensible slang has certainly been the R.A.A.F. Whereas Sherlock Holmes might have deduced that peasant, pig and pot respectively mean an ordinary rank, an officer, and a cylinder, it would require superhuman powers of deduction to understand that a drongo is a raw recruit, to keep yow is to act as an observer, or that a yike is a dogfight. The surprising fact that a pongo snake can tell a sprog to lift his undercarriage is explained by the circumstance that a pongo snake is an English sergeant, a sprog an ordinary soldier, and to lift your undercarriage means get out! You can get this information from any chief sproggery, which is the place where N.C.O.'s in charge of flights meet to discuss general plans. If the nest (aerodrome) is big, then ask the way from any emu or rouseabout (ground staff) or zoomer (member of an air crew). If anybody asks you for a coiler, curler, burn or twirly, you had better give him a cigarette, otherwise he is apt to laugh (grumble) at your surliness. And if you find yourself in the cactus (in trouble) then its just a plain case of Fooism, caused by Foo, the fictitious person to whom all lapses and bungling are attributable.

Meanwhile, however, in addition to Austral-English is to be found Beach-la-Mar, a fearful jargon spoken (and written) throughout the West Pacific in some 250 different versions. (See "Beach-la-Mar" by William Churchill, former U.S. Consul-General in Samoa and Tonga. Pamphlet published in 1911 by the Carnegie Institution of Washington.)

Summing it up, Baker speaks of good English as being "a fiction beloved of littérateurs, smatterers and pundits." In defence of slang he terms as a "pseudo-academic fixation" the idea "that there is a definable something called good English which is pure and beautiful and eternal, and that everything else is bad English."

So why shouldn't the "boirds" go on "choirpin" in Brooklyn?

UNIVERSAL LANGUAGE?

The great pioneers of aviation were quick to prophecy the language problems which would arise from an aerial transportation system bridging frontiers and oceans. Only three years after Henri Farman's first kilometre-flight, the famous French aircraft builder and aeronautical enthusiast, Ernest Archdeacon, had completed a book entitled "Pourquoi je suis devenu espérantiste" (Fayard, Paris, 1910). Henri Farman wrote the introduction, but not as a mere perfunctory favour. It so happened that both men were interested in the universal language question, as well as in aeronautics. Archdeacon, like all his countrymen, loved the River Seine, and liked to pass his time in his house-boat. On board were drawn up the original plans of the "Aeroplan Archdeacon." Alongside this, however, the two pioneers used to burn the midnight oil in attempts to solve language problems. They did this not as a mere hobby, but as part of their efforts to promote aviation. The house-boat was christened "Esperanto" — Hope: hope that one day Man would fly, but also hope that Man would evolve a means of conversation intelligible to all.

* * *

It is logical that the first auxiliary languages arose from the requirements of international traffic. Lingua Franca was developed by Venetian and Genoese sailors coming into contact with customers and passengers from the Levant. The adventurous followers of that enlightened Portuguese prince, "Henry the Navigator," carried this language around much of the world, so it is no wonder that its Latin-Italian roots lent growth to the oddest words and expressions. (Fragments of Lingua Franca are also to be found in Beach-la-Mar.)

Today we have a veritable plethora of artificial and auxiliary languages. In many instances we are unaware that we are dealing with auxiliary languages. In principle, of course, the formulae of the chemist (Berzelius) the mathematician, the astronomer, and even the musical signs are nothing but signs and formula modes of speech evolved in order to facilitate and ensure international comprehension. In this special category of formula speech also belong the Morse code and the other codes used in radio-telephony and radio-telegraphy. Hitherto, in aviation, we have only been concerned with the general understanding between mechanics, passengers and the public. Communication with ground stations or other aircraft has always been maintained with the help of code language, or better said, codes, since these are many.

In this respect, of course, the efforts of the ICAO Communications Division come immediately to the fore, since this body is valiantly endeavouring to establish a standard aeronautical radio code. It so happens that the War turned the code field into a real paradise for inventors, and it is no easy matter to disentangle the present jumble.

Best known, however, of the aeronautical codes is the international "Q" Code. In the selection of the words to be transmitted by radio-telephony — which correspond to the radio-telegraphic signs — great care has been taken to incorporate sharply articulated syllables, so as to minimise risks of error. For example the telegraphic SOS signal becomes "Mayday" for transmission by radio-telephony. Other distinct words of this code are "Over," meaning "My transmission is ended and I expect a response from you"; or "Roger": "I have received and understood your last transmission."

One of the main obstacles to a clear understanding between nations has long been the different systems of weights and measures. Here, too, ICAO has sprung into the breach. Just lately member countries have agreed to a unified table which is gradually to come into practice (by 1959) as a standard system for world aviation.

THE AIRLINES' OPINION

If the airlines wished to introduce an international auxiliary language, a sort of Esperanto for their own special purpose, they could hardly complain of a shortage of offers. Since the early proposals of Descartes (1629) and Leibniz (1679), hundreds of such languages have been developed and forgotten. During the second half of the nineteenth century, artificial and auxiliary languages grew up like mushrooms after a warm rainy day. And the inventors revealed almost extraordinary powers of imagination in their choice of names: Monoglottica, Lumina, Solresol, Excelsioro, Catholic Language, Volapük (not to mention Anti-Volapük), Tutonish (or the Anglo-German Union Tongue!!) and Lasonebr. A certain Mr. Tiemer called his language "Timerio." Mr. Max Wald felt sure that the world just couldn't resist a name like "Pankel," and on the cover of his book (1906) he wrote, "The easiest and shortest language for international communication." Here are a few more for the record: Extralingua, Romanal, Simplo, Adjuvilo, Neposlava, Dil, Ro and Spokil.

Meanwhile, the mention of simplified languages cannot help but focus our attention on C. K. Ogden's Basic English. However, Mr. Ogden would not be very pleased if we aligned his ingenious invention in the general ranks of artificial and auxiliary languages. Among his many champions, he can count the late H. G. Wells, who, in his dream-book, "The Shape of Things to Come," wrote:

Ernest Archdeacon, French aviation pioneer and Esperantist.

> "It [Basic English] was made the official medium of communication throughout the world by the Air and Sea Control, and by 2020 there was hardly anyone in the world who could not talk and understand it."

Nevertheless, it seems hard to believe that, in about seventy years' time, the world will be able to manage with the 850 words contained in Basic English. If it does, then it will have to improve its manners, since we now use at least that many words just in being impolite to each other.

* * *

What is the reaction of the airlines to all this ? The majority do not consider it necessary to invest large sums in language courses for their employees. As a rule, English suffices as medium of communication. Pan American World Airways states :

> "Serving some sixty countries and colonies on all the continents, Pan American daily comes into contact with people speaking most of the principal languages of the world and many of the dialects. While knowledge of one or more foreign tongues is obviously desirable in virtually every category of our business, it is not made a condition of employment, except in certain classifications, such as flight attendants... In Pan American's Atlantic Division, which serves Europe, the Middle East and India, and the West Coast of Africa as well, language proficiency is required only of flight stewards and stewardesses, who must speak fluently, in addition to English, one or more of the following languages : Portuguese, French, German, Czech or Slovak."

American Overseas Airlines, British Overseas Airways, Scandinavian Airlines System, Det Danske Luftfartselskap, all of whom we questioned on the subject, answer in much the same manner. As a rule, linguistic proficiency is demanded only of flight attendants. Why ? The answer is simple : because the technical flight crews use English, and local personnel are recruited for foreign branches. AOA, for instance, employs 23 "locals" in Amsterdam, 21 in Berlin, 19 in Copenhagen, 1 in Helsinki, 143 in Frankfurt, 52 in Gander, 15 in Oslo, 6 in Paris and 34 in Stockholm.

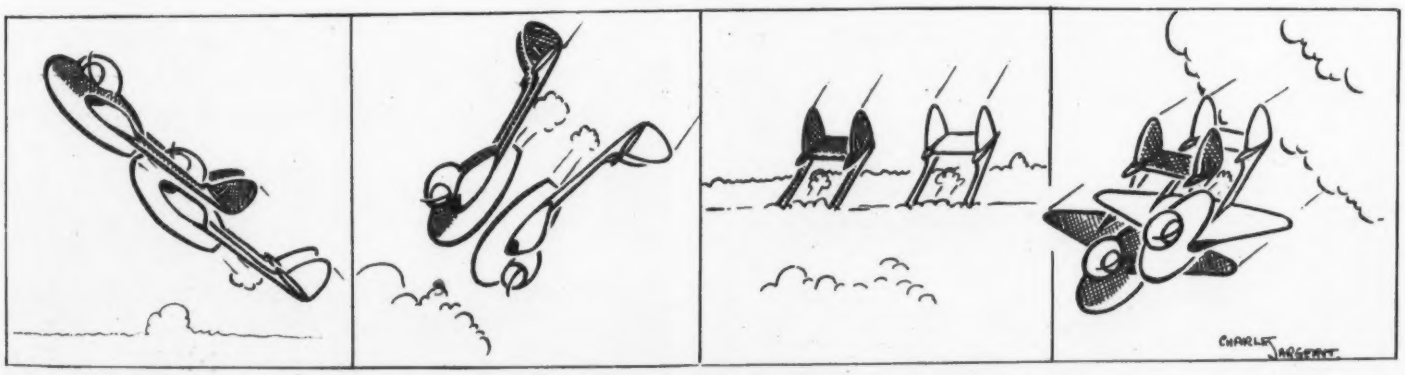
BOAC encourage staff to learn languages by paying bonuses ranging from £25 to £60 for proficiency in specific languages, and a further annual bonus of £10 if proficiency is maintained. But it is not always proficiency which counts in airline operations, as the following BOAC stories clearly reveal. One stewardess had a little difficulty when the company was flying some Greek G. I. brides to America because none of them spoke any English or French. However, the stewardess discovered an English-Greek/Greek-English dictionary and, by its constant use, was able to answer the many enquiries from the excited girls who were going to a new country.

On another occasion a note written in Arabic was received by a BOAC Station Officer overseas. He could neither speak nor write Arabic, so the note was read in Arabic to somebody who could translate it into Hindustani which the BOAC Station Officer could understand. As a result, the answer was promptly forthcoming.

As the Board of SAS is made up of representatives of the three Scandinavian companies, so is the staff of SAS. Similarities in language and national characteristics made cooperation between them natural. They all understand the other's language, but besides Danish, Norwegian and Swedish, English is used as the official company language.

* * *

As you see, therefore, English remains the language of international civil aviation. Some gloomy people might wish to point out that many a world language has been dethroned in the course of history : Greek, Latin, Spanish. But there is really no need to fear a trend of this sort in aviation — not for a long time to come — when one looks at the way the branch is shaping at present.



Analysing the Take-Off

The camera for analysing the take-off, developed by Lockheed Aircraft Corp., is erected behind a grid of vertical and horizontal reference wires. Aft may be seen the runway and a "Constitution" just taking off. The distance between the two vertical wires corresponds to 100 ft. along the runway.

The new structural and acceptance regulations of the U.S. Civil Aeronautics Board have been tightened considerably—with justification—for commercial transport aircraft, and this especially with respect to minimum take-off performance. The International Civil Aviation Organisation, for its part, is endeavouring to obtain general recognition of corresponding minimum standards.

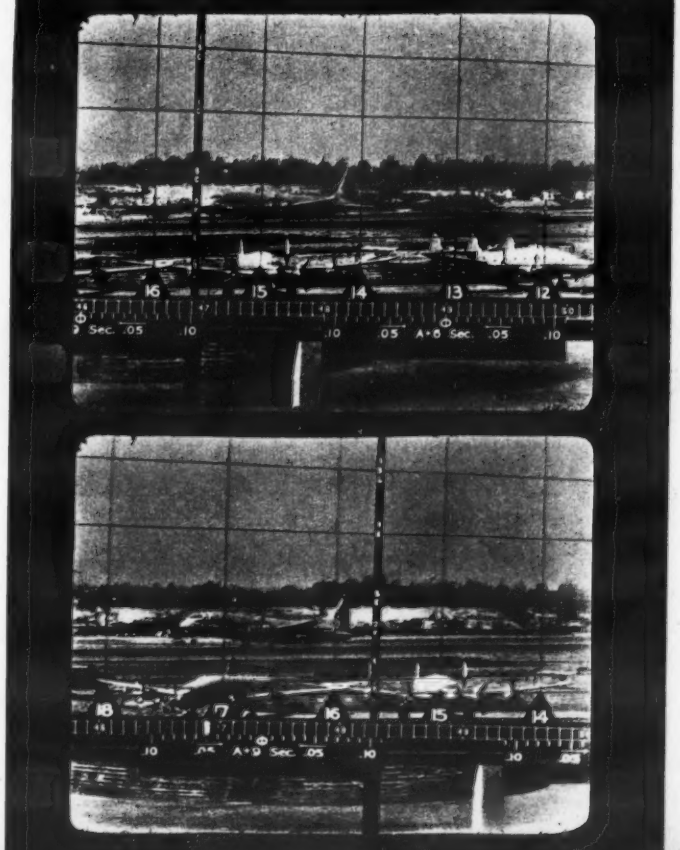
The testing to which every new aircraft type is subjected before being accepted is, alongside the mathematical ascertainment of the construction, significant for the future of the model. Above all lately, there have been many instances in which highly promising prototypes have not been able to pass the acid test until after a long period of time and major modification. It is therefore not surprising that attempts are being made with every means—by both the aircraft industry and the official acceptance bodies—to evolve foolproof and yet extremely simple methods of control, which eliminate erroneous human interpretation in the greatest possible measure.

Every aircraft manufacturing firm is of course free to give the job to its best pilots (acceptance officials flying with them are only too pleased) but "horse swapping" tactics, as were practiced not so long ago during acceptance runs of hydro-electric and similar installations, must not be allowed to enter the domain of aeronautical engineering.

In the present case it is an American aircraft firm that has proposed a new method for analysing take-off performance, which is extremely simple and yet furnishes sufficiently accurate control documents which, without slide-rule labour and mathematical juggling, can be read off direct.

Lockheed Aircraft Corp. use their new device, which they have christened "*Camera Grid*," for analysing the take-off performance of

The entire take-off procedure is filmed through the grid. The time scale beneath the distance markers enables the film to be evaluated with great precision.



their newest giant airliner, the "Constitution" ; and the accompanying photos show how this is done.

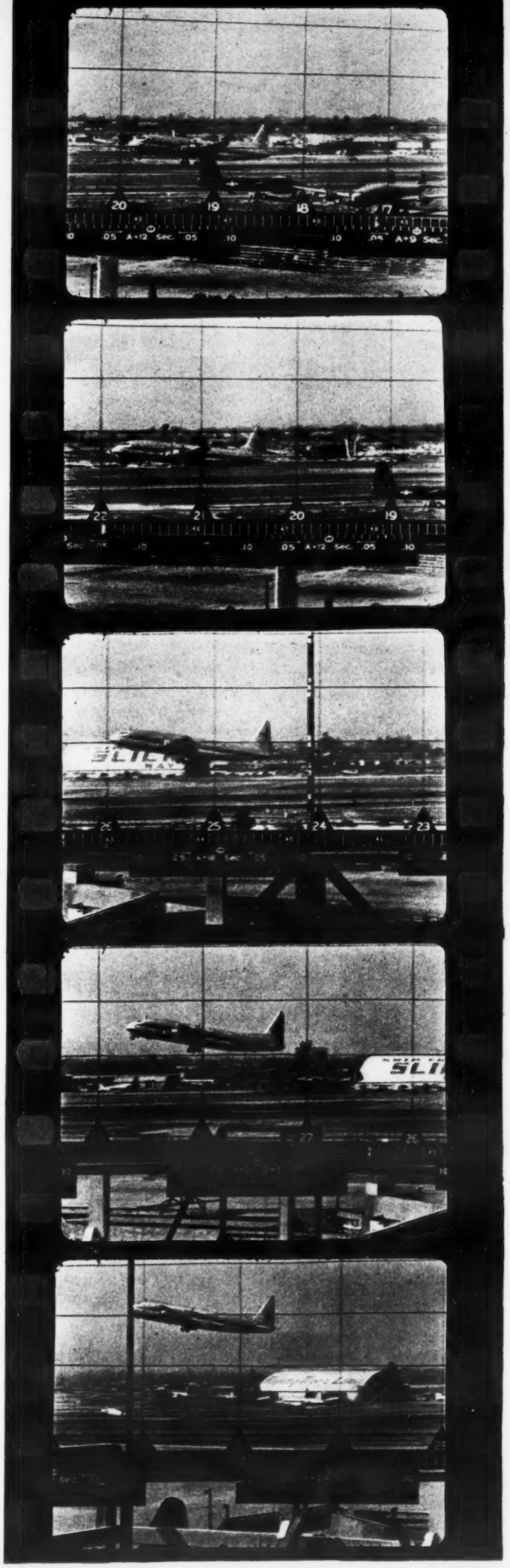
There is really nothing new to using a cine-camera for measuring procedures which take place at high speed. In the present instance, however, it does not concern the assessment of a procedure which only happens in horizontal direction, but of one which also occurs in altitude. Thus a horizontal path of about 12,000 feet and a vertical one of only about 150 feet have to be covered by the "Grid Camera."

Mr. W.L. Howland, Chief of the Lockheed Flight Test Instrumentation Group, therefore designed the following installation. At about the middle of the runway over which the aircraft will be examined is a grid-like structure of about 10 ft. height and 64 ft. length, featuring an elliptical plan section. Between horizontal supports, vertical wires are spanned ; seen from the camera placed some 20 ft. behind, these wires divide the runway into segments of 100 ft. length. They are positioned between triangular tables that are numbered from right to left, and on which the actual path of the aircraft along the runway appears. Similarly, horizontal wires are spanned, though no longer straight but featuring accurately-computed curvatures. In the picture, however, they appear as horizontal lines and enable the exact height of the aircraft above runway level to be read off during the entire take-off procedure.

The installation would be incomplete if the time factor were not brought into the picture by some means or other. On the lower edge of the grid, therefore, is a moving tape which, powered with a synchronous electric motor, moves at exactly constant speed under the vertical distance markers. The metal tape is marked in seconds and tenth seconds, these time divisions being visible on the film. As this was nevertheless considered insufficiently accurate, and since it was moreover discovered that it was advantageous to have the metal tape moving a few seconds before the beginning of the actual take-off, the following procedure was conceived : at 14 points below the tape a series of reference tables have been placed (at least one such table must be completely presented on each film picture), which enable a simple time correction to be made and furthermore, thanks to a vernier scale calibration, make it possible to read off the time with an accuracy of 100th second either way. A judicious choice of lens makes it possible to obtain a sharp picture of an aircraft 2,000 feet away, simultaneously clearly reproducing the grid wires and the time scale.

For the test flight the "Constitution" had a reference sign in the form of an inverted "T" painted on the side of the fuselage (near the centre of gravity) ; at the start of the test the aircraft was positioned so that the vertical line of the "T" was exactly aligned with the "O" vertical wire of the grid. In order to record the exact take-off moment without delay on the film, flashing lights are installed in the side of the fuselage ; these automatically indicate when the brakes are released. As a further control there is a light within the camera, which is flashed by radio impulse and focused on the edge of the film track. As a final check, two lights in the side of the fuselage remain without tension as long as any part of the landing gear is loaded.

In the present case, the camera and time tape were set in motion just as the engines were being revved up to full power. The evaluation showed the take-off to have commenced (brakes released) after 38 seconds. The first picture of the film track shown here indicates the simplicity of the evaluation. The zero marker point of the vernier scale is exactly below the 49-second mark of the time tape. It is only necessary to subtract 38 and add the correction given by the vernier scale (A plus 6 sec.) to see that this picture concerns the 17th second of the take-off. During this time the "Constitution" (compare the fuselage mark with the vertical grid wires) had covered 1,480 feet. As can be seen from the two lights on the side of the fuselage, the landing gear struts were no longer loaded. The other pictures may be evaluated in the same way : a comparison of the fuselage mark with the horizontal grid wires gives an exact altitude for every period of time.



BY WILLIAM GREEN, LONDON

Considerable attention has recently been focused on the Canadian-built DC-4M airliner, the early versions of which have such a fine record of service over the arduous North Atlantic route. Canadair Limited, the manufacturers of the DC-4M, are offering the airframes on a pay-as-you-earn system and, as the Rolls-Royce "Merlin" engines are available in Great Britain—the Canadian product therefore being obtainable for a considerably smaller dollar outlay than would American "Constellations"—it is considered possible that this airliner may be ordered for service with British Overseas Airways Corporation.

The designation DC-4M is actually a misnomer, as can be seen from the following explanation of its ancestry in the Douglas lineage. The original specification was evolved by Trans-Canada Air Lines who, during the summer of 1943, commenced looking for an aircraft for post-war use over their North Atlantic route. Among designs considered, the most suitable appeared to be the Lockheed "Constellation" and the Douglas "Skymaster," both of which were likely to be available for immediate post-war use. After a careful consideration of both designs, TCA engineers decided that the "Skymaster" was preferable of the two aircraft except as regards performance, in which the "Constellation" had the advantage. The higher performance of the "Constellation" was, however, considered somewhat offset by the economical advantages of the "Skymaster," and an analysis of the two aircraft, as contemplated by their manufacturers in 1943, showed the "Skymaster" to be capable of carrying some 5,000 lbs. of payload more than the "Constellation" when used on the North Atlantic route. However, TCA did not consider the Pratt & Whitney "Twin Wasp" engines as suitable for their projected operations.

In November of 1943, the Canadian government decided to build a four-engined commercial airliner and selected the DC-4 on TCA's recommendation. This decision gave TCA the opportunity of specifying their exact requirements : exceptional ease of component replacement ; and installation of liquid-cooled Rolls-Royce "Merlin 620" engines, as these would come nearest to their requirements for high-altitude trans-Atlantic operations.

In the meantime, the Douglas company, apprehensive of the competitive factor offered by the "Constellation's" superior speed, decided to build three basic post-war versions of the DC-4 design, the DC-4A and B—primarily for use over domestic routes—and the DC-6 for trans-Atlantic operation. The DC-4A and B were merely commercial adaptations of the later C-54 "Skymaster" military transport, whereas the DC-6 was to be equipped with a fully-pressurised cabin and thermal de-icing, but was still very much in the development stage. Thus, as the designs of the commercial variants of the "Skymaster" were still in a very fluid state, the Canadians decided to incorporate the best features of all the variants in their version. How the components of the various Douglas models were combined to produce the DC-4M can be ascertained from the following : DC-6 :- fuselage centre-section (shorter by 80 inches), fuselage nose section and landing gear ; DC-4 :- rear-fuselage section, empennage, flap, wing fillet, and wing tip ; C-54G :- wing centre-section, tank section, wing outer panel and wing centre-section nose.

In order to satisfy TCA's specification, which called for considerable power plant interchangeability and fire protection, Canadair engineers, in co-operation with their Rolls-Royce contemporaries, removed all engine-driven accessories, which normally contribute to differences in power plants, and reduced to a minimum the number of connections between power plant and aircraft. Maximum accessibility to all fire-wall connections was provided, and all accessories whose failure would result in inflammable liquids being freed, were located aft of the fire-wall—anticipating rigid CAA requirements on this subject. The adoption of an auxiliary gearbox, attached to the firewall and motivated from

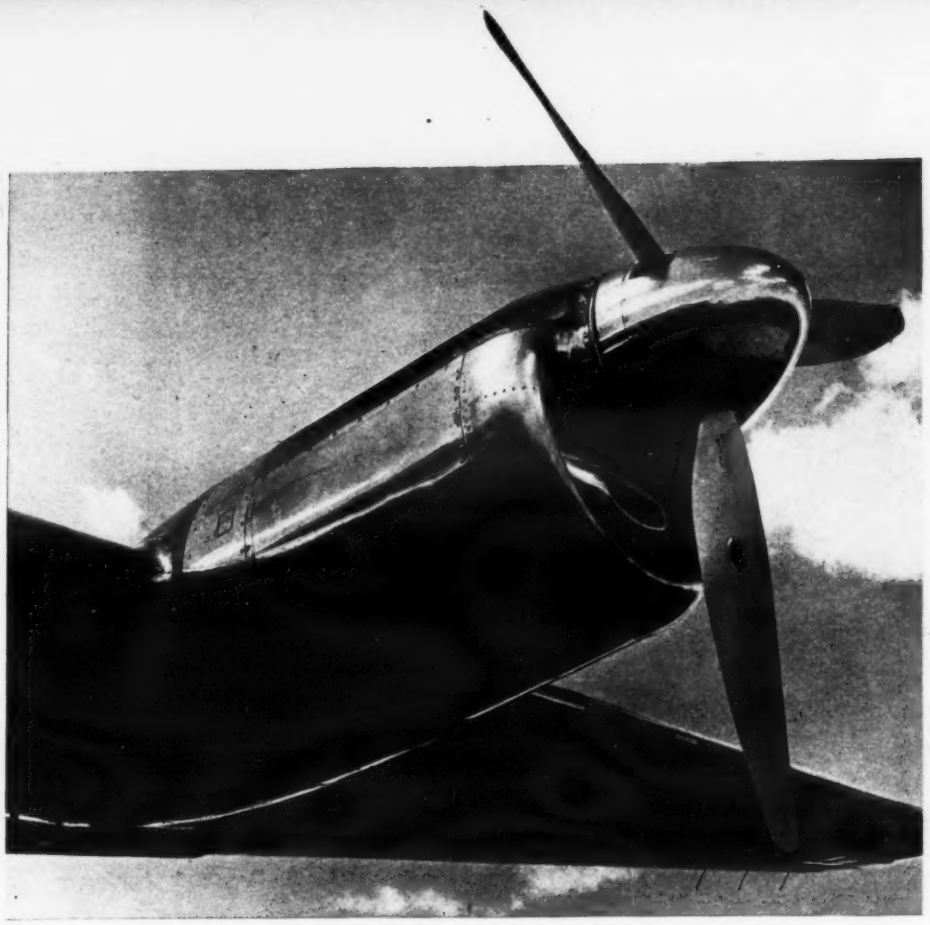
The inspiration : Douglas DC-4 with Pratt & Whitney "Twin Wasp" air-cooled engines (1,450 H. P. take-off and 1,100 H. P. rated power).

the engine via a flexible and easily disconnected shaft, afforded a means whereby TCA's exacting requirements could be satisfied. The gearbox carried all the aircraft accessories and provided for the location of the hydraulic pump. This afforded a 25 per cent. reduction in the number of connections. A high-pressure methyl bromide fire extinguishing system was adopted, and a two-shot manifold system was designed with additional protection for each air induction system. The oil system of the DC-4M was designed to fulfil the requirements of increased oil capacity and high-altitude cold-weather operation.

The electrical system of the DC-4M was based upon that of the C-54, but included portions of the DC-6 electrical system. Additionally, many new installations were engineered by the Canadian manufacturers: for instance, a multi-bus d-c power supply system consisting of four generators, four carbon pile voltage regulators and four reverse current circuit breakers and relays; the airscrew synchronising circuit, and airscrew feathering and starting circuit; all engine controls with the exception of the throttle; the ground power circuit; the a-c power supply (two 115-volt, 1,200 V.A., three-phase, 400-cycle inverters with a split bus system); and so forth. The radio racks and antennae of the DC-4M were entirely re-designed. Radio aids now include dual ADF, localiser, glide path and marker receivers for SCS-51, Loran equipment, 10-channel crystal control HF transmitter/receiver, 18-channel crystal control VHF transmitter/receiver, radio-operator's tunable transmitter and receiver for communications and LF range operation. Individual operation for each member of the crew is provided by a four-channel isolation amplifier.

The hydraulics and landing gear were adapted from the original Douglas DC-6 designs, but incorporate various modifications. One alteration was the installation of a completely re-designed braking system. The new system, lighter and simpler for maintenance, embodies four Bendix three-rotor brake assemblies, and a Bendix power valve which reduces pressure from 3,000 lb./sq.in. to the brake operating pressure required.

The air-conditioning system of the DC-4M is a slightly re-designed version of that used in the Douglas DC-6. The superchargers are positioned directly in-line with the gearbox drive and have a new drive shaft embodying a torsion shaft and spherical couplings designed for a speed range of 2,000 to 8,200 r.p.m.



The cowling of the Merlin 624 encloses the frontal radiator. The latest DC-4M-2 has three-blade propellers incorporating a lower reduction ratio; this steps up performance and cuts down noise.

Considerably shorter than that of the DC-6, this shaft effectively eliminates the whipping problem. Interior layout was adapted from the DC-6, as well as all furnishings with the exception of the seats, which were specially designed to TCA's requirements.

The first version of the DC-4M to enter service with TCA was the 4M-1, a non-pressurised 36-seat adaptation of the military C-54G-M, six of which were acquired. Upon the completion of TCA's order for the fully-pressurised DC-4M-2, the earlier models will be returned to the R.C.A.F., for whom they were originally intended, and re-converted for military transport duties. Versions of the DC-4M-2 include 40- and 48-passenger day airliners and a 20-berth sleeper airliner. The DC-4M-1 and 2 are known to TCA as the "North Star," Mk. I and Mk. II respectively, whereas the manufacturers call the latter model "Canadair Four."

The first "North Star" Mk. II flew the Atlantic and arrived at London Airport on September 4th of last year. Flying non-stop from Montreal to London, it covered 3,290 miles in 10½ hours at an average speed of 313 m.p.h., and at an average altitude of 21,000 feet. On the return flight, it set up a record for the Vancouver—Montreal route by flying the 2,345 miles at an average ground speed of 342 m.p.h.

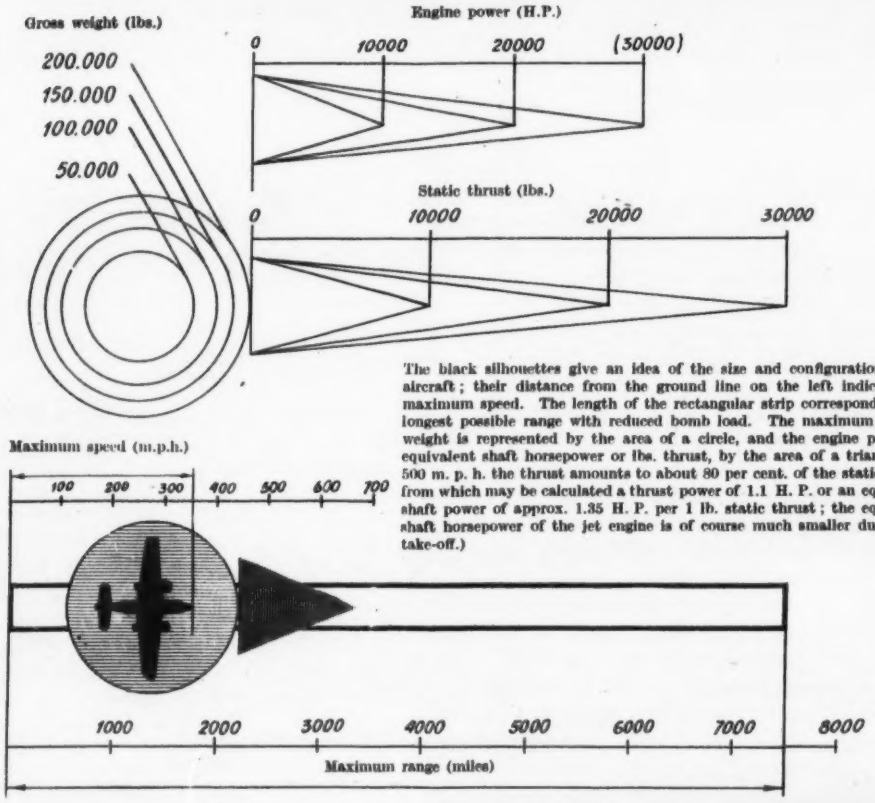
Canadair DC-4M with Rolls-Royce "Merlin" liquid-cooled engines (1,760 H. P. take-off and 1,400 H. P. rated power). One of the reasons for TCA's choice of the more powerful "Merlin" is because Canadian runways are snow-covered for a greater period of the year and therefore demand greater take-off power for the same aeroplane than runways in other countries.

CHARACTERISTICS AND PERFORMANCE OF THE DC-4M-2

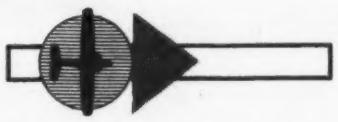
Four Rolls-Royce "Merlin 624" engines, each delivering 1,760 H.P. take-off power; propeller reduction ratio of 0.42; Hamilton Standard "Hydromatic" three-blade propellers.

Span	117 ft. 6 in.
Length	93 ft. 5 in.
Height	27 ft. 6 in.
Wing area	1,457 sq.ft.
Max. take-off weight	80,200 lbs.
Max. landing weight	68,000 lbs.
Manufacturers' weight empty (continental)	45,444 lbs.
Manufacturers' weight empty (oceanic)	45,620 lbs.
Max. payload (oceanic)	13,851 lbs.
Wing loading at max. take-off	55.04 lb./sq.ft.
Wing loading at max. landing	46.5 lb./sq.ft.
Power loading at take-off	11.4 lb./sq.ft.
Max. cruising speed (at 20,000 ft.)	333 m.p.h.
Stalling speed (80,200 lbs., sea level, no flap)	124 m.p.h.
Stalling speed (68,000 lbs., sea level, flaps 40-deg.)	87 m.p.h.
Rate of climb (sea level, full take-off)	16 ft./sec.
Rate of climb (three engines, 19,500 ft., full take-off)	2.75 ft./sec.
Service ceiling (full take-off)	26,500 ft.
Take-off run (80,200 lbs., sea level)	2,900 ft.
Landing run (68,000 lbs., sea level)	2,760 ft.
Max. range (8,800 lbs. payload, 220 m.p.h., 10,000 ft.)	4,000 miles
Range (13,860 lbs. payload, 275 m.p.h., 23,000 ft.)	2,500 miles

Long-Range Bombers of Today

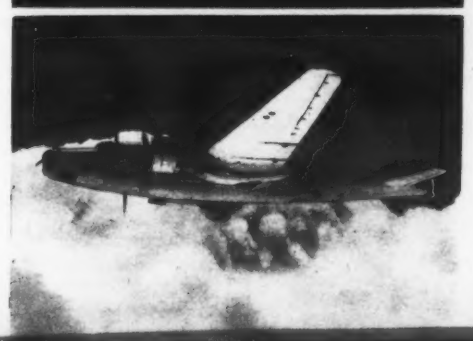


The black silhouettes give an idea of the size and configuration of the aircraft; their distance from the ground line on the left indicates the maximum speed. The length of the rectangular strip corresponds to the longest possible range with reduced bomb load. The maximum take-off weight is represented by the area of a circle, and the engine power, in equivalent shaft horsepower or lbs. thrust, by the area of a triangle. (At 500 m. p. h. the thrust amounts to about 80 per cent. of the static thrust, from which may be calculated a thrust power of 1.1 H. P. or an equivalent shaft power of approx. 1.35 H. P. per 1 lb. static thrust; the equivalent shaft horsepower of the jet engine is of course much smaller during the take-off.)



Convair PBY-5 "Catalina" (U.S.A.)

Vickers-Armstrongs "Warwick V" (G.B.)



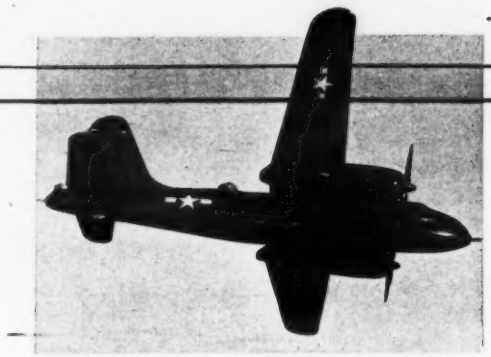
Our serial presentation of present-day aircraft types began in the March issue with a review of the latest piston-engined fighters. The April issue carried a similar article on jet fighters; the May and June issues were devoted to personal aircraft. This month continues the series with a review of the medium-heavy and heavy bomber aircraft.

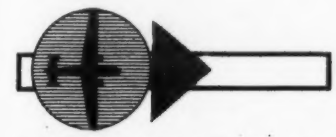
It was apparent from the first article of this series that, for certain types of bombing and for torpedo attacks, fighter aircraft can be used. It is difficult to make a distinct division between these fighter bombers or torpedo fighters and the more specialised attack aircraft, so that we also included the single-seater attack aircraft in our general survey of fighter aeroplanes.

It is therefore logical that we should now continue the series with the two- and more-seater attack aircraft These, too, can for the most part be classed under the collective name of "bomber" aircraft. Such types may be classified according to the method by which they drop their bombs, so that we have attack bombers, which drop their bombs in low, steep or dive flight and are endowed with good flight performance characteristics, particularly for operating right over the target area, and aircraft which one could almost call bomb transports, since they are primarily designed for long-range flying and carrying heavy war loads

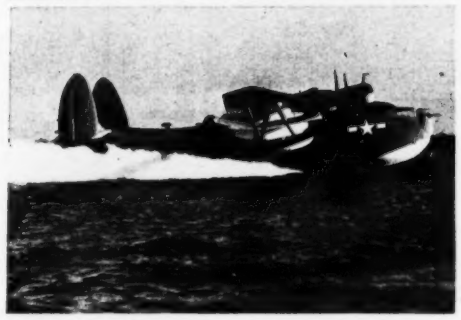
For the present let us leave aside the attack bombers and concentrate on the last-mentioned

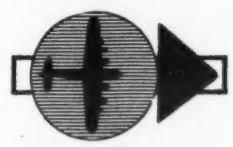
Lockheed P2V "Neptune" (U.S.A.)



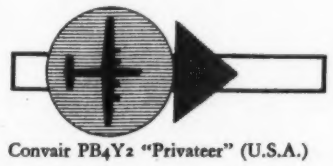


Martin PBM-5A "Mariner" (U.S.A.)

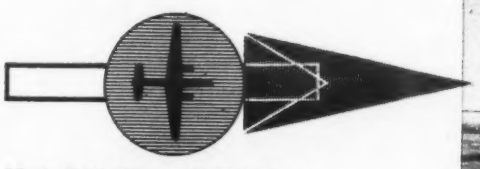




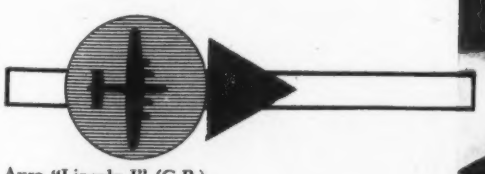
Short S-25 "Sunderland" (G.B.)



Convair PB4Y2 "Privateer" (U.S.A.)



Martin P4M "Mercator" (U.S.A.)



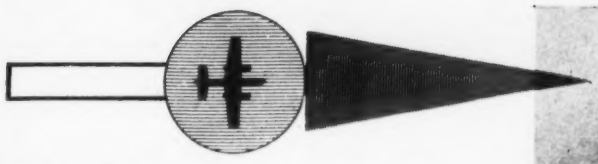
Avro "Lincoln I" (G.B.)

types of bomber. If we classify them according to increasing gross weight, we find in the first half of our list the so-called patrol bombers—marine aircraft which fly long distances over water, spot enemy submarines, and so forth, and destroy them with bombs. As a rule they operate outside the range of enemy fighters and are never used for attacks against strongly protected targets. For this reason the group also includes flying-boats and older types of landplane with relatively low speed. The "Catalina," "Mariner" and "Sunderland" flying-boats, for instance, still exist in fairly large numbers. But even for flying over the high seas, the landplane, thanks to its higher wing loading, has managed to deprive the flying-boat of its top place on the list. For instance, the old four-engined Army bomber, the Consolidated B-24 "Liberator," still lives on in its naval guise as the PB4Y-2 "Privateer," just like the British twin-engined Vickers "Warwick," with which a number of R.A.F. Coastal Command units are at present equipped. Of all these types, however, the Martin "Mariner" is the only one still in serial production.

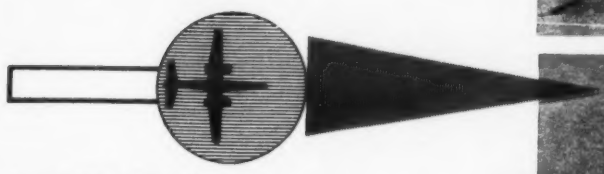
As regards new reconnaissance bombers, there are only two which can be mentioned, and both are American: the twin-engined Lockheed P2V "Neptune," of which the suitability for long-range flying is evident from its hitherto unbeaten distance record of 18,082 kms. (Perth, West Australia, to Columbus, Ohio, in 1946). A faster and larger aircraft is the Martin P4M "Mercator," which is the only patrol aircraft to feature jet-propulsion engines in addition to reciprocating units, the jet engines being for additional power over short periods.

The largest bomber at present being produced in Europe, the Avro "Lincoln," developed from the successful "Lancaster" bomber of the last war and today the standard long-range bomber of the Royal Air Force, neither has the high speed of the new U.S. jet bombers, nor does it bear comparison as regards gross weight with the big bombers listed on the last page of this article. But it all the same carries a bomb load equal to that of the Boeing B-29.

The four American bombers shown here are jet propelled and represent the *avant-garde* of the bomber manufacturing industry. Their speed is far in excess of that of piston-engined aircraft, and they are probably capable of carrying out many of the attack manoeuvres otherwise attributable to the best jet fighters, which can only be allowed to approach sonic speed with the utmost caution. Their armament, concerning which there is a dearth of precise data, is presumably a lot weaker than that of usual bombers of the same size; in all likelihood it primarily consists of fixed nose



North American B-45 (U.S.A.)



Convair XB-46 (U.S.A.)

guns and remote-controlled rear guns. Another characteristic of these bombers is the small number of crew members in relation to their size—two pilots and one bomb-aimer; the North American B-45 can eventually take on a rear gunner.

Perforce, the range of these four types still remains a mystery to the public. It is said to compare favourably with that of conventional bombers, though this seems surprising in view of the high fuel consumption characteristic of turbine engines. Since at least the North American B-45 is called a "tactical bomber," it is evident that the present-day jet bombers belong in a different category from that of strategic long-range bombers. And because their speed quickly approaches critical values in dives, it is clear that they cannot compete

Country	Manufacturer	Designation	Crew	Power plant	Max. engine power	Max. static thrust	Dimensions			Weights			
							Span	Length	Wing area	Max. take-off weight	Wing loading	Power loading	
					H.P.	lbs.	ft. in.	feet	sq. ft.	lbs.	lb./sq. in.	lb./H.P.	lb./lb.[3]
U.S.A.	Convair	PBY-5 "Catalina"..	6	2 × P & W "Twin Wasp"	2,400	—	104'	63' 10"	1,400	34,000	24.3	14.2	—
G.B.	Vickers-Armstronga..	"Warwick V"	6	2 × Bristol "Centaurus VII"	5,000	—	96' 8½"	75' 6"	1,006	45,000	44.8	9.0	—
U.S.A.	Lockheed	P2V "Neptune" ...	7	2 × Wright "Cyclone 18".	5,000	JATO	100'	78'	1,000	60,000 [1]	60.0	12.0	JATO
U.S.A.	Martin	PBM-5A "Mariner".	9	2 × P & W "Double Wasp"	4,600+	JATO	118'	77' 2"	c. 1,400	64,000 [2]	c. 45.7	13.9	JATO
G.B.	Short Bros. ...	S-25 "Sunderland" .	9	4 × P & W "Twin Wasp"	4,800	—	112' 10"	85' 4"	1,687	65,000	38.5	13.5	—
U.S.A.	Convair	PB4Y-2 "Privateer"	11	4 × P & W "Twin Wasp"	4,800	—	110'	78' 8"	1,048	65,000	62.0	13.5	—
U.S.A.	Martin	P4M "Mercator"...	10	2 × P & W "Wasp Major" 2 × Allison J-35	6,000+ —	— 8,000	114'	82' 6"	1,300	81,900	63.0	13.6 —	— (10.2)
G.B.	A. V. Roe & Co.	"Lincoln I"	7	4 × R-R. "Merlin 85" ...	6,540	—	120'	78' 3½"	1,421	82,000	57.8	12.5	—
U.S.A.	North American	B-45.....	4	4 × General Electric J-35..	—	16,000	89' 6"	74'	c. 1,080	78,000+	72.0+	—	4.8+
U.S.A.	Convair	XB-46	3	4 × General Electric J-35..	—	16,000	113'	105' 9"	c. 1,300	91,000	c. 70	—	5.7
U.S.A.	Boeing	XB-47 "Stratojet"..	3	6 × General Electric J-35.. 18 × JATO	—	24,000 18,000	116'	108'	c. 1,400	125,000	c. 89	—	3.0
U.S.A.	Martin	XB-48	3	6 × General Electric J-35..	—	24,000	108' 4"	85'	1,300	c. 110,000	c. 85	—	4.6
U.S.A.	Boeing	B-29 "Superfortress"	14	4 × Wright "Cyclone 18"	8,800	—	141' 3"	99'	1,739	140,000	80.5	15.9	—
U.S.A.	Boeing	B-50.....	14	4 × P & W "Wasp Major"	14,000	—	141'	99'	1,739	140,000+	80.5+	10.0+	—
U.S.A.	Northrop.....	B-35.....	15	4 × P & W "Wasp Major"	12,000+	—	172'	53' 1"	4,000	209,000	52.3	17.4	—
U.S.A.	Northrop.....	YB-49	13	8 × General Electric J-35..	—	32,000	172'	53' 1"	4,000	200,000+	50+	—	6.3+
U.S.A.	Convair	B-36.....	16	6 × P & W "Wasp Major"	18,000+	—	230'	163'	4,772	278,000	58.3	15.4	—

[1] 85,000 lbs. with overload for distance record flight.

[2] Land take-off; 56,000 lbs. for water take-off.

[3] Jet-propelled; based on static thrust.

Boeing XB-47 "Stratojet" (U.S.A.)

Martin XB-48 (U.S.A.)

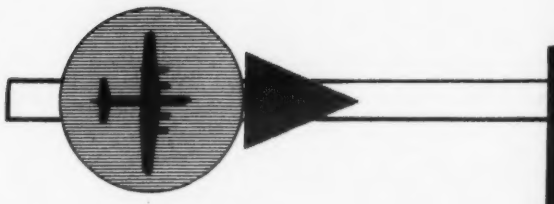
with conventional tactical attack bombers in this respect. Accordingly, therefore, the jet bomber could be called a "tactical horizontal bomber," which releases its bombs from smaller or greater altitudes whilst flying past targets located more or less near to the front line, without having to change its flight direction in any great measure.

The conclusion to this list is formed by the big bombers as such, beginning with the well-known Boeing B-29 "Superfortress," used to drop the first atom bombs, and its more powerful B-50 successor. About half as heavy again are the Northrop B-35 "Flying Wing" bomber with piston engines and its YB-49 jet-propelled counterpart. And the climax is provided by the Convair B-36 long-range bomber, which features the truly remarkable

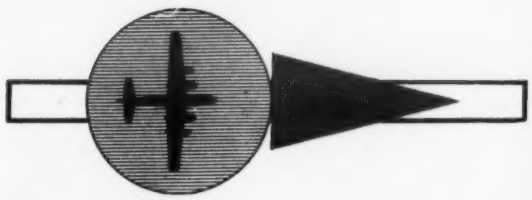
Performance				Max. bomb load	Defence armament [4]				Additional armament and special equipment T = Torpedo (instead of bombs) R = Rocket missiles	Remarks, other versions
Max. speed	Service ceiling	Range			Nose station	Waist stations		Rear station		
m.p.h.	feet	max. miles	normal miles	lbs.		Number	Arms			
195	18,000	—	3,100	*c.* 4,400	.. MG	2	.. MG	—	2 × T	PBY-5A amphibian. Photo shows latest PBY-6A version with stronger armament
c. 295	....	....	....	6,000	1 MG	2	2 MG	4 MG	Leigh light ; mines or depth charges	345 m.p.h. with Napier "Sabre"
300+	23,000	(11,236)[1]	3,500	8,000	6 MG	1	2 MG	2 MG	Atom bombs ; radar 2 × T ; 2 × R of 11.75 in. ; 16 × R of 5 in.	
200+	....	....	3,000	4,000	2 MG	3	4 MG	2 MG	2 × T ; radar	Amphibian version of PBM-5 flying-boat
215	18,000	....	2,050	*c.* 7,000	2 MG	3	8 MG	2 MG		
250+	36,000	3,000+	2,000	6,000	2 MG	4	8 MG	2 MG		Development of "Liberator"
400	32,500	....	3,000	12,000	4 MG	1	2 MG	2 AC	Radar	
315	24,500+	4,450	1,350	22,000	2 MG	1	2 AC	2 MG	Boulton Paul Type D turret with radar sight	Licence-built in Australia
480+	40,000+	....	....	20,000	.. MG	..	....	.. AC	Pressurised crew compartment with refrigeration	
....	....	....	....	....	....	..	....	....	Pressure cockpit with jettisonable hood	
500+	....	....	....	20,000+	—	—	—	2 MG	Pressure cockpit with refrigeration	Bicycle landing gear
480+	....	....	....	20,000+	....	..	....	....		Bicycle landing gear
350	33,000	8,150	....	20,000	—	4	10 MG	2 AC	Pressure cabin ; central gun firing system with automatic computer	
400	....	5,000+	....	33-44,000	—	4	10 MG	2 AC	Pressure cabin ; central gun firing system with automatic computer	
370+	....	10,000	....	33-44,000	—	6	16 MG	—	Pressure cabin ; external MG turrets remote controlled	
c. 500	....	....	....	33,000+	....	..	....	....	Pressure cabin	
300+	40,000	10,000	....	86,000	....	..	....	....	Parasite fighters ; central gun firing system ; pressurised compartments	

[4] MG = Machine gun of 0.303 or 0.5 in calibre. AC = automatic cannon of 20 mm. or more

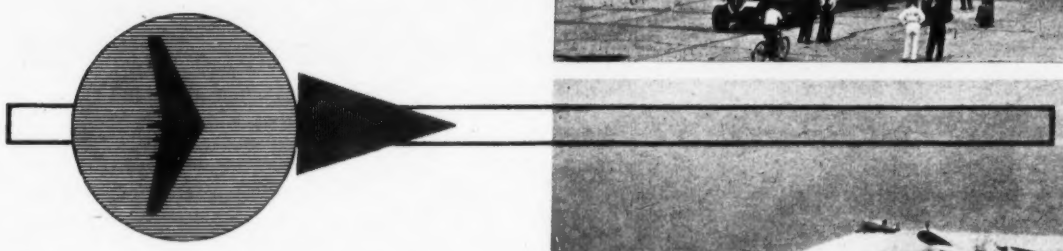
[1] Two bombs of 43,000 lbs.



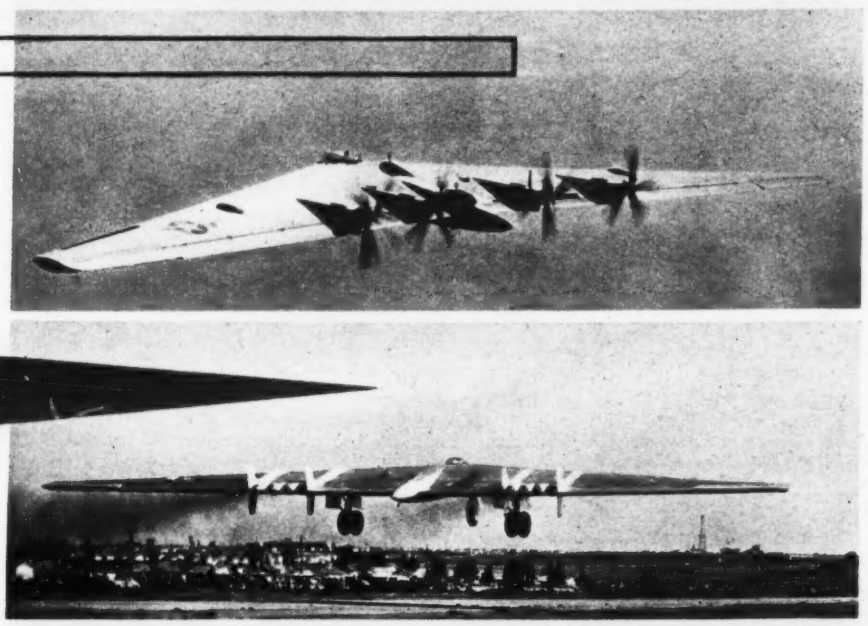
Boeing B-29 "Superfortress" (U.S.A.)

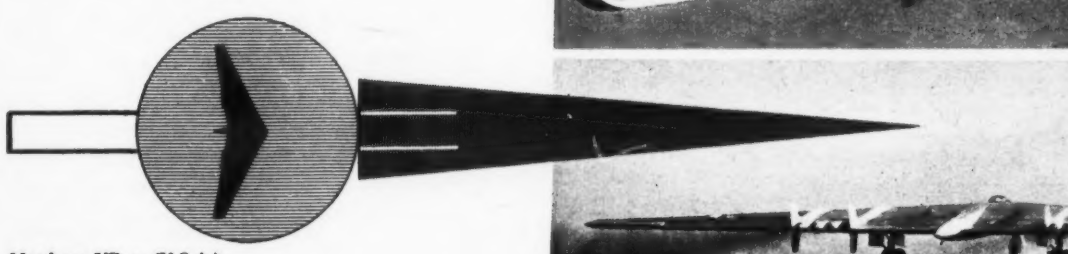


Boeing B-50 (U.S.A.)

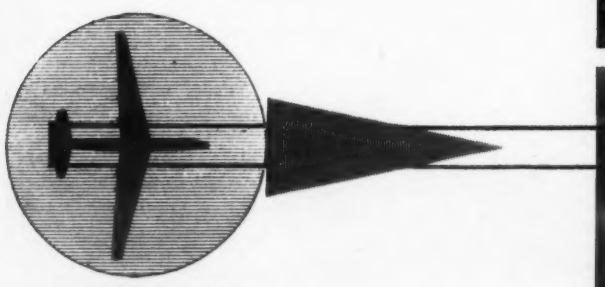


Northrop B-35 (U.S.A.)





Northrop YB-49 (U.S.A.)



Convair B-36 (U.S.A.)

span of 230 ft. To each and every one of them might be attributed the now almost forgotten name of "Flying Fortress." Their strength lies not so much in their speed as in their ability to remain in the air for a very long time, and to fly correspondingly long distances if the target is strategically worth while. Naturally, like the jet bombers, they are fitted with air-conditioned, pressurised cabins, in view of the considerably greater altitudes chosen for attacks today. Their defence armament is extensive and can quickly and accurately be put into action in any direction by electrical means from a central control station. And the newest feature is the possibility of having a small interceptor fighter take off from the big bomber ; not having to return to earth, this can combine very high-speed, manoeuvrability and firing power.

RECTIFICATION

In the June issue two errors occurred in the article on "Modern Personal Aircraft." On page 316 the SNCA du Nord "Norécrin" is the aircraft marked F-BBBO and the Saab "Safir" the one marked SE-APN. Similarly, on page 317 the Baumann "Brigadier" (NX 30025) is erroneously coupled with the caption pertaining to the Portsmouth "Aerocar Major," and vice versa.

Theory of Thrust Augmentation

By Dr. C. W. SMITH, *Aircraft Gas Turbine Engineering Division, General Electric Co., U.S.A.*

Introduction

The first flights of jet-propelled airplanes had scarcely been completed when attempts were begun to increase the thrust of the conventional jet power plant by the use of special devices. The three methods usually considered are :—

1. burning of additional fuel in the tailpipe ;
2. injection of a liquid of high latent heat into the compressor or combustion chamber ;
3. use of a jet or rotary augmentor.

Thermodynamically, burning in the tailpipe merely adds a small auxiliary Brayton cycle to the main cycle. The static pressure in the tailpipe is not much above atmosphere, so that the efficiency of this auxiliary cycle (a function of pressure ratio) cannot be high. Although considerable increases of thrust are possible, the high specific fuel consumption limits operation to short periods of time.

Large increases of thrust can also be obtained with liquid injection, but again at the cost of increased fuel consumption. If it were possible to recover the latent heat by subsequent condensation, the economy might be improved, but this is hardly practicable in an airplane.

The use of a jet or rotary augmentor requires no additional fuel, and any increase of thrust results in a decreased specific fuel consumption. Only this type of augmentation will be considered here.

A distinction must be made between an "augmentor" and a "ducted fan." The primary function of an augmentor is to increase the thrust, or the product of mass flow and jet velocity. The function of the ducted fan is to make the ratio of mass flow to jet velocity (for a given product) as favourable as possible for a given airplane velocity, and thus to ensure the highest practicable propulsive efficiency (a function of the ratio of airplane to jet velocity). Even though a device intended as an augmentor does not actually increase the thrust, it may serve the entirely distinct purpose of improving propulsive efficiency. In this paper, however, only the basic function of an augmentor is considered ; if there is no increase of thrust, it is considered that there is no useful output.

Jet Augmentor

In the jet augmentor (Fig. 1) the products of combustion from the power plant (hereafter called primary air, since the composition differs only slightly from that of atmospheric air) are not discharged from the propulsion nozzle directly to atmosphere, but to the interior of another duct, usually of constant cross-section except near the entrance. The primary air leaving its nozzle drags along secondary air by viscous action, and the resulting decrease of pressure causes further flow of secondary air. As the secondary air is accelerated, the primary air is decelerated, and with a sufficiently long duct, the entire mass may be considered to leave at the same velocity. Thus at the end of the augmentor duct, which now becomes the effective discharge point of the system, the mass flow is greater, and the velocity is less, than if only the conventional nozzle had been used. Whether the product of mass flow and velocity is greater will depend upon the augmentor efficiency.

Rotary Augmentor

A rotary augmentor is merely an auxiliary turbo-compressor. After the gas issues from the main turbine, it passes through the blades of the augmentor turbine, thereby giving up part of its available energy, and being discharged from the propulsion nozzle with a correspondingly lower velocity. The augmentor turbine drives an augmentor fan, or low-pressure compressor, which takes air from the atmosphere, imparts velocity to it, and then discharges it to the rear, either at the same velocity as the discharge gases from the augmentor turbine, or at a somewhat different velocity, and either mixed with these gases or through a separate nozzle. The compressor and turbine blades may be attached to the same disc, as indicated in Fig. 2, or there may be a separate compressor impeller. In other words, the rotary augmentor provides a separate mechanical pump to accelerate the secondary air, rather than rely merely upon the viscous drag forces, but its function is basically the same as that of the jet augmentor.

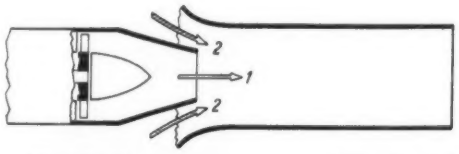


Fig. 1: Jet augmentor (diagramatic).
1. Primary air (products of combustion from power plant)
2. Secondary air (from atmosphere)

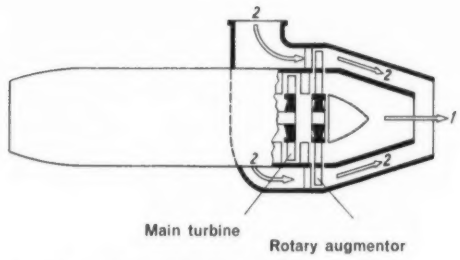


Fig. 2: Rotary augmentor (diagramatic)
1. Primary air (products of combustion)
2. Secondary air (from atmosphere)

The rotary augmentor would normally operate at a considerably lower speed than the main turbine. It might use the same shaft, but would turn freely on this shaft. Some means might be provided for controlling the speed, but normally this would not be done, and the design should be such that the highest speed which can be attained in service is safe. If it is desired to cut the augmentor out entirely, some suitable by-pass arrangement should be provided, since a large loss would result if the air were forced to pass through stationary blades. Naturally such a by-pass arrangement would result in considerable complication.

Preliminary Considerations

It is evident that when an augmentor is used on an airplane in flight, there is an additional resisting thrust caused by taking the secondary air on board, and this thrust must be considered in determining the net gain. In either type of augmentor, there will evidently be losses : in the jet, by reason of the large viscous friction, and in the rotary, by reason of the usual turbine and compressor losses. While the losses, as such, may be less in the latter, a rotary type will usually be heavier, more bulky, and more costly if it is designed for reasonably high efficiency.

If it were possible to take the secondary air entirely from the boundary layer on a wing or other aircraft surface, it could be considered that there is no additional resistance caused by taking it on board. It is true that there is a resisting thrust involved in accelerating atmospheric air up to airplane velocity (or in decelerating it to zero velocity relative to the airplane), but this will occur in any case, and is part of the normal airplane drag. The boundary layer air is never actually reduced to zero velocity and carried along with the plane ; it is eventually discharged and replaced by fresh air, so that the resisting thrust is continuous.

In order to make the analysis perfectly general, it will be assumed that the secondary air is taken on board at a velocity V_{is} relative to the airplane. For the conventional leading-edge intake, V_{is} is equal in magnitude, and opposite in direction, to the airplane velocity V. For complete boundary layer intake, $V_{is} = 0$. Partial boundary layer intake may be represented by some equivalent intermediate value.

It is evident that the gain which is possible from an augmentor in high-speed flight will depend upon (1) the efficiency of the augmentor itself, and (2) the magnitude of any net gain in the mV product as compared with the resisting thrust caused by taking the secondary air on board. In the case of the jet augmentor, gas at a high temperature and high velocity mixes with air at a low temperature and low velocity, so that there will be a transfer of heat from primary to secondary air during the process. This will be ignored in the mathematical analysis, as it will have no essential bearing on the conclusions drawn.

It is convenient in the analysis to use certain velocity ratios, rather than the velocities themselves, since it is shown that the possible gain is a function of these ratios, and not of the particular velocities. The gain is also a function of the ratio of mass flow of secondary air to mass flow of primary air, and of augmentor efficiency. This efficiency will be defined as the ratio of the increase of kinetic energy of the secondary air to the decrease of kinetic energy of the primary air.

Symbols

g = acceleration of gravity
$m = w_s/w_p$
$p = V_p/V_0$
$q = V_{is}/V_0$
$r = V/V_0$
V = airplane velocity
V_0 = discharge velocity of primary air without augmentor
V_p = discharge velocity of primary air with augmentor
V_s = discharge velocity of secondary air
V_{is} = initial velocity of secondary air
w_p = mass flow of primary air
w_s = mass flow of secondary air
η = augmentor efficiency ; i. e., the ratio of the increase in kinetic energy of the secondary air to the decrease in kinetic energy of the primary air.

The velocities V_0, V_p, and V_{is} are all relative to the airplane. Most favourable values of m, p, q, r, and η are denoted by the subscript b (best).

Mathematical Analysis

If the velocity of the primary air is decreased from V_0 to V_p by the augmentor, the power available for accelerating secondary air is :

$$\frac{w_p (V_0^2 - V_p^2)}{2g} \qquad (1)$$

This power may be used to increase the velocity of a relatively small flow of secondary air by a relatively large amount, or to increase the velocity of a relatively large flow by a small amount. In the case of a simple jet augmentor, the secondary air velocity cannot be increased to a value greater than V_p, but with a rotary augmentor this limitation does not exist. Although in the latter case it would be physically possible for either the primary or the secondary air (but not both) to be discharged at a relative velocity which is less in magnitude than the airplane velocity V, it is evident that there is no advantage in doing so in the normal case, so that it may be assumed that both primary and secondary air must be discharged with a relative velocity at least equal to V.

To any secondary flow w_s there will correspond a secondary velocity of discharge V_s such that :

$$\frac{w_s (V_s^2 - V_{is}^2)}{2g} = \frac{\eta \cdot w_p (V_0^2 - V_p^2)}{2g} \qquad (2)$$

Solving for V_s :

$$V_s = \sqrt{V_{is}^2 + \eta \frac{w_p}{w_s} (V_0^2 - V_p^2)} \qquad (3)$$

The positive thrust resulting from an acceleration of flow w_s from V_{is} to V_s is :

$$\frac{w_s}{g}(V_s - V_{is}) = \frac{w_s}{g}\left[\sqrt{V_{is}^2 + \eta \frac{w_p}{w_s} (V_0^2 - V_p^2)} - V_{is}\right] \qquad (4)$$

The loss of thrust (or negative thrust) resulting from a deceleration of flow w_p from V_0 to V_p is :

$$\frac{w_p}{g} (V_0 - V_p) \qquad (5)$$

The net gain is the difference :

$$\frac{w_s}{g}\left[\sqrt{V_{is}^2 + \eta \frac{w_p}{w_s} (V_0^2 - V_p^2)} - V_{is}\right] - \frac{w_p}{g}(V_0 - V_p) \qquad (6)$$

Taking out the factor $w_p V_0/g$, and substituting the symbols for the various velocity and mass flow ratios as defined in the list of symbols, this becomes :

$$\frac{w_p \cdot V_0}{g}\left[\sqrt{m^2 q^2 + \eta \cdot m (1 - p^2)} - mq - (1 - p)\right] \qquad (7)$$

Dividing by (w_p/g) $(V_0\text{-}V)$, which is the thrust without an augmentor, and multiplying by 100, the percent gain is :

$$\frac{100}{(1 - r)}\left[\sqrt{m^2 q^2 + \eta \cdot m (1 - p^2)} - mq - (1 - p)\right] \qquad (8)$$

This expression is a function of η, m, p, q, and r. Of these, η, q, and r will usually be fixed in any particular case, leaving only m and p to be adjusted for maximum gain. Nevertheless, since there may be some range of selection possible for η, q, and r, the separate effects of these variables will also be examined after determining the most favourable values of m and p.

If all variables are held constant except m, it is evident by inspection of (8) that the percent gain will increase from a minimum when $m = 0$ to a maximum when $m = \infty$. If the first derivative with respect to m is equated to zero, it is found that there is no maximum or minimum point between these values.

If $q = 0$, the percent gain is :

$$\frac{100}{(1 - r)}\left[\sqrt{\eta \cdot m (1 - p^2)} - (1 - p)\right] \qquad (9)$$

which increases indefinitely as m increases, although at relatively slow rate.

If q is not zero, formula (8) may be written in the form :

$$\frac{100}{(1 - r)}\left[m \cdot q\sqrt{1 + \frac{\eta}{m}\frac{(1 - p^2)}{q^2}} - mq - (1 - p)\right]$$

The radical may be expanded in the series :

$$(1 + x)^{\frac{1}{2}} = 1 + \frac{x}{2} - \frac{x^2}{8} + \frac{x^3}{16} \cdots$$

where :

$$x = \frac{\eta}{m}\frac{(1 - p^2)}{q^2}$$

so that the percent gain is :

$$\frac{100}{(1-r)}\left[mq+mq\frac{x}{2}-mq\frac{x^2}{8}+mq\frac{x^3}{16}\cdots \cdots -mq-(1-p)\right]=\frac{100}{(1-r)}\left[\eta\frac{(1-p^2)}{2q}-\eta^2\frac{(1-p^2)^2}{8mq^3}+\eta^3\frac{(1-p^2)^3}{16m^2q^5}\cdots-(1-p)\right] \quad (9a)$$

This also increases as m increases indefinitely, but for large values of m approaches the limit :

$$\frac{100}{(1-r)}\left[\eta\frac{(1-p^2)}{2q}-(1-p)\right] \quad (10)$$

If q is very small, this limit approaches infinity, thus verifying the deduction drawn from (9).

If all variables except p are held constant, the most favourable value of p is found by differentiating (8) with respect to p and equating the first derivative to zero. Noting that the second derivative is negative, it is found that the percent gain is a maximum when p is equal to :

$$p=\sqrt{\frac{1+\frac{mq^2}{\eta}}{1+\eta m}} \quad (11)$$

The most favourable ratio is therefore a function of m, q, and η. It is not physically possible for the ratio to be greater than unity, however, so that the further restriction must be imposed that :

$$\eta m > \frac{mq^2}{\eta} \text{ or } \eta > q \quad (12)$$

so that :

$$\frac{q}{\eta} < 1 \quad (13)$$

If (11) is written in the form :

$$p=\sqrt{\frac{\frac{1}{m}+\frac{q^2}{\eta}}{\frac{1}{m}+\eta}}$$

it is evident that for large values of m the most favourable value of p approaches the limit :

$$p_b=\frac{q}{\eta} \quad (14)$$

If this value is to be used in practical cases, however, it is necessary that :

$$\frac{q}{\eta} > r$$

since p must be greater than r.

Substituting this value into (10), the maximum possible percent gain for the most favourable values of m and p used simultaneously is :

$$\frac{100}{(1-r)}\left[\frac{1}{2\,q/\eta}+\frac{q/\eta}{2}-1\right] \quad (15)$$

Considering now the effect of the semi-fixed quantities η, q, and r, it is evident from (8) that the percent gain increases continuously as η increases from zero to its maximum possible value of unity. However, the rate of increase is rather slow, since η occurs only under the radical sign, so that there is probably a rather early limit to the size to which augmentation equipment should be increased for the sake of high efficiency.

It is evident from (15) that the gain is equal to zero when $q=\eta$, and increases continuously to a maximum (infinite gain) as q decreases to zero. It is easily shown that there is no maximum or minimum point between these values. This can also be deduced from (9a). Boundary layer intake is therefore definitely desirable if it is practicable.

The ratio r is largely fixed by the airplane speed. It can be shown that the propulsive efficiency is a function of r, and is a maximum when $r=1$, or $V=V_0$, decreasing steadily to zero as r decreases to zero.

Since q/η must always lie between r and unity, $q/\eta=1$ when $r=1$. In this case (15) reduces to the form o/o, and it is necessary to make further investigation to determine the limit approached.

The difference between r and q/η becomes infinitesimally small as both approach unity. Formula (15) may then be written :

$$\frac{100\left[\frac{1}{2r}+\frac{r}{2}-1\right]}{1-r} \quad (16)$$

The derivative of the numerator with respect to r is $100\left(-\frac{1}{2r^2}+\frac{1}{2}\right)$ which approaches zero as r approaches unity. The derivative of the denominator is a constant, -1. Therefore the percent gain becomes zero when $r=1$.

To determine the variation of (15) as r decreases from unity to zero, taking due account of the fact that the permissible lower limit of q/η is always equal to r, it is necessary to determine how the relative magnitudes $\frac{1}{2\,q/\eta}$ and $\frac{q/\eta}{2}$ vary as q/η decreases.

When $q/\eta=1$, each of these terms is equal to $\frac{1}{2}$. The term $\frac{q/\eta}{2}$ decreases at a constant rate $\frac{1}{2}$, found by taking the first derivative of the term with respect to q/η. The term $\frac{1}{2\,q/\eta}$ increases at a constantly accelerating rate $\frac{1}{2(q/\eta)^2}$ found in a similar manner, and since q/η is always less than unity, this rate of increase is always greater than the rate of decrease of $\frac{q/\eta}{2}$. Therefore the quantity inside the brackets of formula (15) increases continually as q/η decreases. This means that the greatest gain is obtained when the lowest permissible velocity ratio :

$$p_b=\frac{q}{\eta}=r \quad (17)$$

can be used. Under these conditions the percent gain steadily increases as r decreases. Expressed in another way, the possible gain steadily decreases as the airplane speed increases.

At take-off or standstill, both r and q are zero. It follows from (15) that the theoretical percent gain is infinite, but it also follows from (14) that the most favourable value of p is zero in this case.

This merely indicates that maximum gain is theoretically obtained by utilising all the kinetic energy in the primary air to accelerate an infinite mass flow of secondary air to an infinitely small velocity. Although this is an impossibility in practice, the direction to be followed in the design of an augmentor is clearly indicated.

It is evident from (8) that, for any given values of η, p, and q, a certain minimum value of m is required if the gain is to be positive. It is necessary that :

$$\sqrt{m^2q^2+\eta m\,(1-p^2)} > mq+(1-p)$$

Squaring both sides, cancelling the terms containing m^2, and transposing, this becomes:

$$m > \frac{(1-p)}{\eta\,(1+p)-2q} \quad (18)$$

For a constant value of q, the required secondary flow necessary to ensure positive gain decreases as p increases, reaching a minimum for $p=1$, and a maximum for $p=r$.

For constant values of p and η, the required flow is a minimum when $q=0$, corresponding to boundary layer intake. For this case :

$$m > \frac{(1-p)}{\eta\,(1+p)} \quad (19)$$

For the other extreme value of q, corresponding to leading edge intake, $q=r$, and :

$$m > \frac{(1-p)}{\eta(1+p)-2r} \quad (20)$$

In the special but nevertheless representative case when $p=r$, this becomes :

$$m > \frac{(1-r)}{\eta-(2-\eta)\,r} \quad (21)$$

It is clear that the minimum flow of secondary air required will be much diminished if boundary layer intake can be used.

Summary

The most favourable values of the various parameters are as follows :

$p_b = q/\eta$ $\qquad$ $r_b = 0$

$q_b = 0$ $\qquad$ $m_b = \infty$

$\eta_b = 1$

The greatest gain is obtained when the ratio of secondary flow to primary flow is as large as practicable, and when the velocity ratio p is equal to q/η, subject to the restrictions that :

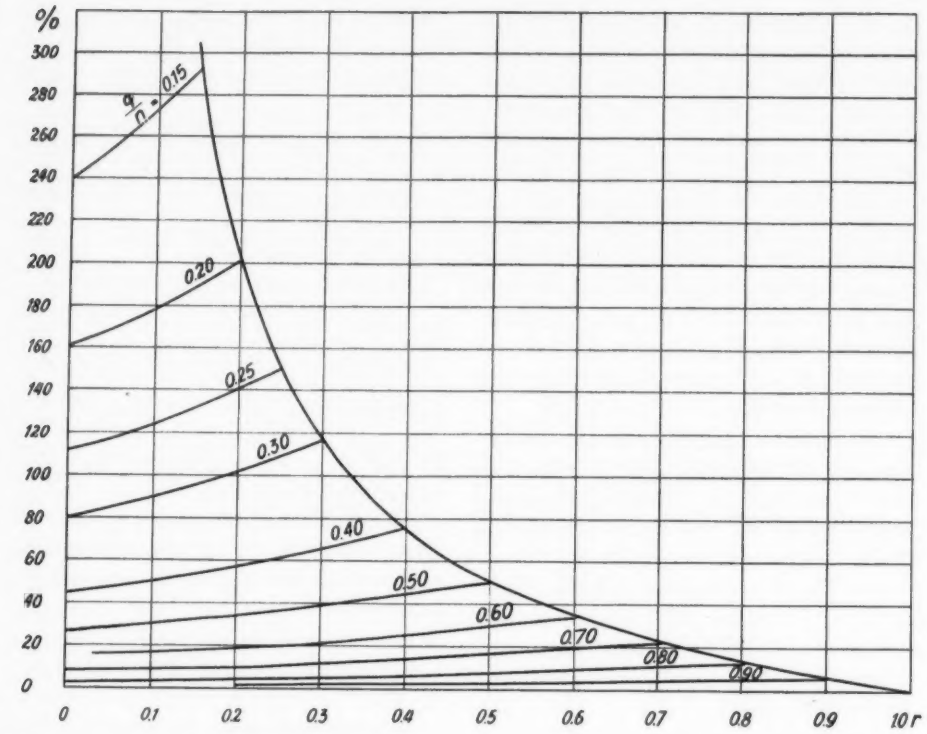


Fig. 3: Maximum possible percent gain in thrust versus r (ratio of airplane speed to jet velocity). Parameters: q/η; best values for p and m.

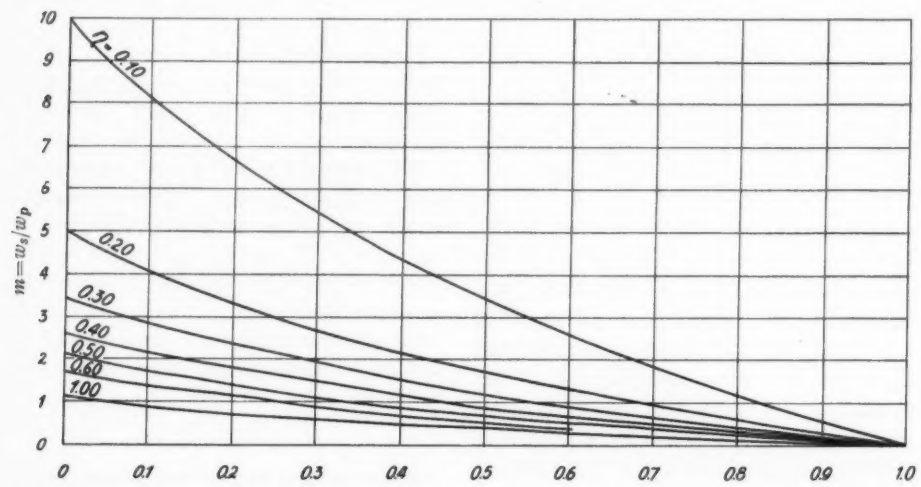


Fig. 4: Minimum ratio of secondary air flow to primary air flow required for positive gain in thrust, for complete boundary layer intake of secondary air ($q = 0$), versus p and η. $p = V_p/V_0$

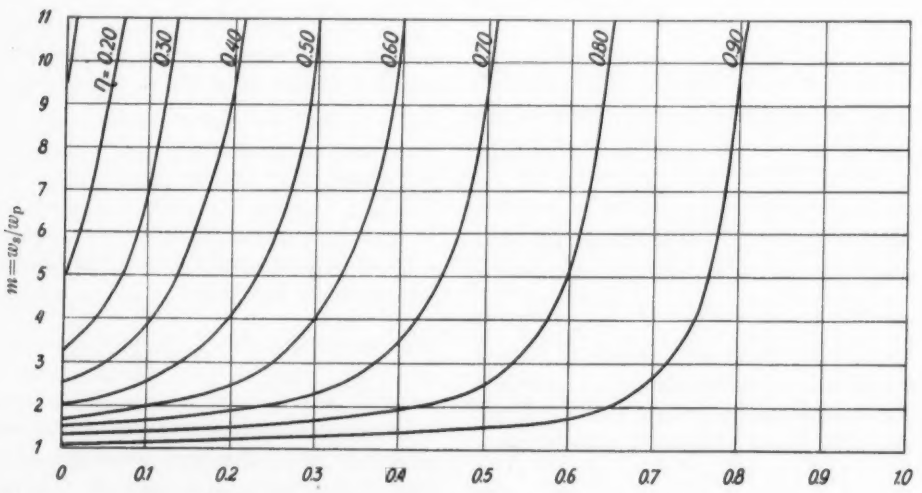


Fig. 5: Minimum ratio of secondary air flow to primary air flow required for positive gain in thrust, for complete leading edge intake of secondary air ($q = r$), versus p and η. Assumed is that $p = r$ or $V_p = V$. $p = V_p/V_0 = r = V/V_0$

$$1 \geq p \geq r \geq q$$

$$\eta > q$$

The maximum possible percent gain in thrust for given values of q, r, and η when the most favourable values of m and p are used is given by formula (15), values of which are plotted in Fig. 3. The percent gain for any combination of values of the parameters may be calculated by formula (8).

In the case of take-off or standstill ($q = 0$ and $r = 0$), it is impossible as a practical matter to use the velocity ratio $p = 0$, but maximum gain is obtained when the ratio is kept as small as possible and the secondary flow as large as possible.

In any case a certain minimum flow of secondary air is necessary for positive gain. Values of minimum flow required for extreme values of q [equations (19) and (21)] are plotted in Fig. 4.

General Conclusions

It should be easily possible to design an augmentor which will give a considerable gain in thrust at take-off, although this will require a reasonably good efficiency if the size is not to become unduly large. Such test data as are available support this conclusion, and also indicate the desirability of a large ratio of secondary air to primary air.

For normal operation at high flying speeds, there appears to be little promise in any type of augmentor, jet or rotary, with conventional leading-edge intake. If, however, boundary layer intake can be successfully used without interference with the aerodynamic qualities of the airplane, and without addition of excessive weight and complication of equipment, there is a possibility of successful augmentation. Very little is known about the problem at present, and flight or wind tunnel tests, preferably on a reasonably large scale, will be necessary before final decisions can be made.

Pictured above are crew members of the automatic C-54 which completed the automatic trans-Atlantic flights. Left to right are : Capt. Roman J. Whiting, navigator ; Capt. Thomas J. Wells, test pilot ; Colonel James M. Gillespie, chief of the All-Weather Flying Division and commander of the automatic C-54 ; Mr. James L. Anast, chief of the Automatic Flight Branch and author of this article ; T/Sgt. Raymond Centolella, radio operator ; S/Sgt. John C. Nimon, engineer ; and T/Sgt. Welker W. McKee, crew chief. Not pictured above is another crew member, Mr. George B. Johnson, project engineer of the Automatic Flight Branch.

Automatic Aircraft Control

By James L. ANAST,
Chief, Automatic Flight Branch, USAF All-Weather Flying Division, Wilmington, Ohio

On September 21st and 22nd, 1947, a Douglas C-54 " Skymaster " of the U.S. Air Force crossed the Atlantic by automatic control. The take-off was from Stephenville, Newfoundland, and the landing at Brize Norton, Oxfordshire, England. On board were a nine-man crew and five observers (including two from the RAF), but the flight controls were subjected to no human intervention from the moment the aircraft began rolling down the runway to take-off, until the moment it rolled to a standstill at Brize Norton. The automatic flight control equipment which made this possible is described below by the chief of the research unit entrusted with the task of developing it.

The Editor.

It is now common knowledge that the control a pilot exercises over a large modern aircraft when flying under instrument conditions is marginal to the point of affording, in some cases, very little safety factor. This is not surprising when it is considered that on the DC-4 (or C-54) there are no less than 36 instruments indicating temperatures, manifold pressures, speeds, and fuel quantities of four great engines that produce over 5,000 horsepower. There are, in addition, more than 20 instruments relating directly to the flying attitude and orientation of the aircraft. Over and above these instruments, there are many controls for the secondary adjustments of navigational aids, which are extremely important during instrument conditions.

During the more critical portions of a bad weather flight, the take-off, approach and landing, the safe conduct of the aircraft actually becomes a question of probabilities. There exists today a great discrepancy between the number of manual functions that the pilot may be called on to perform, particularly during approach and landing, and the capabilities of a human being in carrying out their adequate control. One needs very few demonstrations to prove that the pilot must be aided considerably in the execution of his duties in today's aircraft, if a reasonable safety factor is desired. The complexity of the control equipment with which a pilot is confronted has naturally led to the investigation and development of automatic devices to reduce the pilot's burden.

It has been necessary to turn to the field of electronics, whose history has taken us from radio aids, through instrument approach systems and automatic pilots, to the high performance radio and radar equipment now being developed as integral components of aircraft control systems. Until very recently the automatic pilot has been of small comfort to the pilot under instrument conditions, except for the relief of fatigue. The last few years, however, have seen great strides in the integrated use of automatic pilots with the radio coordinate systems that have been developed for human use. The automatic pilot today is in a motor-response sense much superior to the servo system inherent in human beings. We have arrived at a stage where we can release a great number of functions, that a pilot and his crew would necessarily have to perform, to the automatic electronic pilot. Having a fine enough instrument to perform the basic flight functions of maintenance of attitude, turn coordination, and " beam " following, there has naturally been an extensive investigation into the possibility of removing from the pilot the direct responsibility for the execution of short term stability, navigation, instrument approach and landing. In short, we are now at a stage where we can determine the systems required to perform the basic flight functions for the human pilot. It is obvious that pilotless flight for inhabited aircraft is not the goal of this experimentation, but rather the aim is to control automatically the aircraft with sufficient accuracy and reliability to allow the pilot freedom from comprehensive supervision of the operations, and the freedom to make the decisions necessary for the safety of the aircraft under all weather conditions.

The United States Air Force's All-Weather Flying Division, a unit within the Air Materiel Command, has undertaken the development of automatic aircraft control for inhabited aircraft, commencing with the evaluation of the system requirements of automatic aircraft control. As a portion of its investigation a prototype " Automatic Flight Controller " was fabricated, that receives a flight plan and performs the aircraft control functions to accomplish a completely automatic flight from take-off to touchdown in an elementary form. (Figures 1 and 2 : Control Panel, Automatic Flight Controller.) The feasibility of automatic aircraft control does not manifest itself from the quality of the present control, which is limited, of course, by the usage of basic

Fig. 1: The Automatic Flight Controller Mark II, " brain " of the automatic C-54. Located in the main cabin, it weighs approximately 800 lbs. and is powered by an auxiliary gasoline generator.

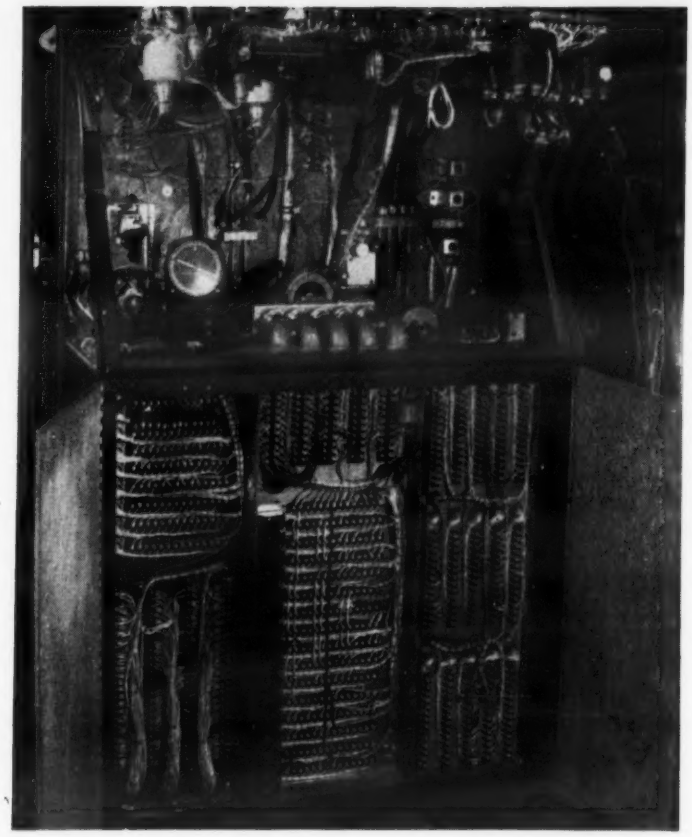


Fig. 2: Control panel of the automatic C-54, shoving Master Sequence Selector, electrical junction boxes, and various electronic coupling units.

systems that are presently in force, but lies in the fact that the DC-4 which is controlled automatically, is safely conducted throughout all the basic phases of take-off, climb, navigation, approach and landing, without human control of the detailed functions normally necessary. The accomplishment of several long-distance automatic flights, notably the one made in September, 1947, from Newfoundland to England, demonstrates the feasibility of even the present limited equipment in an integrated form, to perform crude but completely automatic flights. It must be stated that the work resulting in the " Automatic Flight Controller " is but a skeletal fundament, which remains to be elaborated, modified, and essayed. The accomplishment of successful all-weather flying must be associated with a programme of investigation and evaluation, this in order that the theoretical concepts of all-weather aircraft operation can be refined into realities by actual experimental selection.

The form that automatic aircraft control systems will take in the future will be shaped by experimental results obtained with the prototype controllers now being essayed. Actually, there are no apparent barriers, other than time itself, to prevent the development of aircraft control systems into orderly, safe and foolproof means of full-time operation of multiple aircraft under all weather conditions. The realisation of this, although far away in years, can be envisioned and even designed with the advanced electrical engineering and electronic techniques available today for the manufacture of high-performance automatic pilots, engine control systems, and extremely accurate navigational coordinate systems. It remains to select the types of system to be used, and to develop them into integrated control systems suitable for all-weather operation. This selection, development and attendant evaluation requires, however, extraordinary, concerted engineering effort and invention over a period of years in order to produce a control system that operates with the safety and facility of our railroad systems for example. This, then, is the goal of the All-Weather Flying Division, and to this end the engineers of this Division are set to the task of perfecting the " Automatic Flight Controller " as a vehicle through which an ultimate system of aircraft control can be used universally to solve the problem of aircraft operation under all-weather flying conditions.

As a basic and necessary step, the design of the prototype Automatic Flight Controller resolved itself primarily to the investigation of the adaptability of presently available equipment, such as automatic pilots and automatic radio compasses, to automatic flight control, and the development of ancillary electro-mechanical systems to reproduce the action of a human pilot in receiving flight information from his instruments and the attendant control that he exercises. The equipment is integrated into a system that allows for selection of flight parameters, and for automatic sequential control of the aircraft to produce the predetermined flight. In general, the theory of operation of the Controller involves the utilisation of information from flight instruments that furnish operational data to the control surfaces, engine controls, and auxiliary controls. During the flight, the data given to the Automatic Flight Controller prior to take-off is combined with information

Fig. 3: Automatic pilot rack; from top to bottom: Automatic Approach Coupling, Flight Amplifier, Vertical and Directional Gyroscopes, Inverter and Servo Control Unit.

from the flight instruments to compare their error, and translated to electrical voltages and mechanical forces by units that cause the aircraft to take off, climb, retract the landing gear and flaps, and perform the necessary navigational functions in the correct sequences so as to achieve automatic flight.

The schedule of the flight is determined by the Master Sequence Selector, which is essentially a multi-channel, multi-pole electrical switch that advances in position when its actuating circuit is energised. It connects in the proper sequence the controlling instruments to the automatic pilot and the other auxiliary systems, and " stores " the flight parameters placed in it prior to the flight, so as to advance itself during the flight as each phase is completed. It selects the controlling units, the sequence of operation, and performs the sensory function necessary for automatic continuity in control.

The central equipment used in the " Automatic Flight Controller " is its Sperry E-4 Automatic Pilot (Figure 3), which provides a three-axis attitude reference, magnetic reference for the directional gyroscope, control surface movement proportional to the displacement and rate of displacement error in attitude, automatic coordination of turns, barometric altitude control and automatic elevator trim tab operation. The E-4 Automatic Approach Control is also used to translate radio information from the Air Force Instrument Low Approach System to the automatic pilot, so that in controlling the direction and pitch attitude of the automatic pilot the aircraft is made to follow the radio beams to the landing runway. The Automatic Approach Control output signal is proportional to the azimuth angle of departure from the beam, plus the rate of angular closure. The signal to the pitch control circuit of the automatic pilots is proportional to the vertical angular displacement from the glide path beam.

Fig. 4: Automatic Engine Control Amplifier Rack. These amplifiers operate the governor and throttle servos from a master transmitter which is in turn operated by successive voltages from the Master Sequence Selector. A = Synchronisers.

Described briefly below are some of the automatic coupling units that have been developed to translate basic flight information into actuating impulses for operating the automatic pilot, engines and auxiliary operating units of the aircraft.

Automatic Engine Control System

To provide adequate power, with the correct relationship between manifold pressure and engine speed during the automatic flight, engine condition is controlled, as a function of input reference voltages that are applied by the Master Sequence Selector during the flight, by a servo system that automatically maintains the four engines at the correct preselected manifold pressure, and at an engine speed that is synchronised at a value consistent with safe and efficient operation. With the exception of the sequence in which a constant air speed is maintained, as described later, the engine condition, then, is a function of the phase of the flight. (Figure 4 : Amplifier Rack, Automatic Engine Control System.)

Radio Compass Homer and Orbitter

This is an electronic system which automatically homes the aircraft on a preselected radio station. The voltage from a zero-locked synchronous transformer coupled to the Automatic Radio Compass is fed to an integrator-amplifier whose output is in turn fed to the turn control amplifier of the automatic pilot. Integration is required to prevent varying radio compass signals from influencing the course of the aircraft during conditions of heavy precipitation. This unit is also used with higher sensitivity levels to control the orbitting on a preselected radio station. Automatic tuning of the radio compass is accomplished by the Master Sequence Selector to frequencies selected prior to the flight.

Magnetic Heading Selector

This is an electro-mechanical system operating from the flux valve of the E-4 automatic pilot that turns the aircraft on an arbitrarily selected magnetic heading. A zero-locked synchronous transformer, rotatable through 360 degrees, is used to feed a voltage proportional to the error in heading to the turn control amplifier of the automatic pilot. The appropriate Magnetic Heading Selector is applied during the flight as a function of the Master Sequence Selector.

Pitch Attitude Selector

This is a coupling unit that controls the pitch attitude of the aircraft during the flight. Ascent and descent signals are applied with the vertical gyroscope as a reference, sequentially through the Master Sequence Selector. A servo system is used to apply and remove the signals gradually throughout the flight.

Constant Air Speed Control

It has been found necessary in the approach sequences of the automatic flight where the aircraft is being controlled by an Instrument Low Approach System, that engine power in addition to elevator movement must be controlled. This is done by the use of an air speed sensing element that modifies the engine manifold pressure to maintain the air speed within plus or minus three miles per hour.

Auxiliary Controls

In addition to the primary controls discussed above, the operation of the landing gear and wing flaps is controlled automatically through the Master Sequence Selector, which selects their position throughout the flight.

In order to furnish the intelligence necessary to advance the Master Sequence Selector in sequence, flight sensory equipment has been developed, the most important items of which are described briefly below.

Absolute Altitude Sensor: In order to detect automatically the arrival at certain arbitrary altitudes by the aircraft, the standard Radio Altimeter is utilised to actuate the Master Sequence Selector at 50 feet, 1,000 feet, 2,000 feet and at an altitude arbitrarily selected between 3,000 and 8,000 feet. The range of operation is automatically selected through the Selector to provide optimum operation.

Air Mile Counter: An instrument that integrates the true air speed is utilised to advance the Selector in the navigational sequences. With this equipment it is possible to preselect the number of air miles to be flown, since it furnishes an electrical actuation after an arbitrary number of air miles have been flown.

Localiser and Glide Path Sensors: The intelligence that determines the advance of the Selector in the approach and landing phases is information from electronic units that sense the entry of the aircraft into the localiser and glide path beams of the Instrument Low Approach System. They furnish electrical actuations when the aircraft passes through the exact centre of each of the guiding beams.

The above described equipment is integrated with the Master Sequence Selector and the automatic pilot, and other minor coupling sensory equipments to give an automatic flight that is preselected by the application to the " memory " circuits of the Controller of the desired flight parameters. Figure 5 shows the twelve major sequences of an automatic flight.

1) *Ready to Take Off:* Aircraft with engines running stands at beginning of runway ; master sequence selector in position 1.

2) *Take-Off:* Operator presses starting button (sole manual intervention), which steps selector to position 2. Engines brought to take-off power ; elevator moved in accordance with air speed indication. Aircraft rolls away and takes off ; direction controlled by flux valve.

3) *Transition to Climb:* At 50 feet altitude radio altimeter steps selector to position 3. Engines brought to climb power ; wheels up ; flaps remain down ; direction still controlled by flux valve.

4) *Climb:* At 1,000 feet altitude radio altimeter steps selector to position 4. Climb power and direction (by flux valve) maintained ; flaps up.

5) *Magnetic Heading Control I:* At preselected cruise altitude radio altimeter steps selector to position 5. Engines brought to cruise power ; direction controlled by No. I magnetic heading control. Cruise altitude controlled by Sperry altitude control unit.

6) *Homing Flight to Omni-Range I:* As soon as emissions of omni-range I are received, selector is stepped to position 6. Cruise power and altitude control maintained, but direction now controlled by radio compass (No. I) until aircraft arrives over omni-range I.

7) *Magnetic Heading Control II:* When aircraft passes over omni-range I automatic radio compass direction indicator steps selector to position 7. Cruise power and altitude maintained, but direction now controlled by (preselected) No. II magnetic heading control.

8) *Homing Flight to Omni-Range II:* When aircraft enters receiving range of omni-range II, selector is stepped to position 8. Cruise power and altitude remain unchanged, but direction now controlled by radio compass (No. II).

9) *Orbitting Descent over Omni-Range II:* When aircraft passes over omni-range II, automatic radio compass direction indicator steps selector to position 9. Engines brought to approach power ; altitude control cut out ; aircraft orbits around omni-range II through orbitter of radio compass homer. Since engines are throttled, orbitting flight becomes spiral descent until new signal is given (at 2,000 feet).

10) *Approach on Localiser:* At 2,000 feet radio altimeter steps selector to position 10. Engines brought to cruise power ; wheels and flaps down. Automatic approach and landing control system of aircraft now near enough to respond to airport localiser signals. (In example shown in figure 5, omni-range II is located on centre-line of localiser lobe pattern.) From now on, automatic pilot obtains signals from airport instrument landing system and aircraft follows localiser plane ; altitude control for 2,000 feet maintained.

11) *Automatic Landing:* When aircraft reaches glide path, automatic sensor steps selector to position 11. Engines throttled back to approach power ; altitude control cut out. From now on automatic pilot receives all signals (glide path and localiser) from airport landing system only.[1]

12) *Touchdown to Standstill:* At touchdown nose-wheel micro-switch steps selector to position 12. Engines fully throttled back (idle power) ; brakes actuated, but controlled by accelerometer and localiser to prevent exaggerated braking or skid turning.

Before a system of scheduled aircraft operation can come into being, there are certain necessary developments in the basic flight control that are being attacked by the All-Weather Flying Division in its current programme ; these are the results of the experimental data obtained from the prototype " Automatic Flight Controller " and allied research. The major problem in actual aircraft control is satisfactory automatic landing. Present instrument landing systems that have been developed do not perform probably the most important function that is required in all-weather flying : the controlled flare-out on landing. The All-Weather Flying Division and agencies in the United States and Europe have attempted to soften the impact of landing when using a fixed beam system, but their results have been, at best, approximate solutions that in reality do not exercise absolute control over the aircraft, and moreover have a low order of reliability.

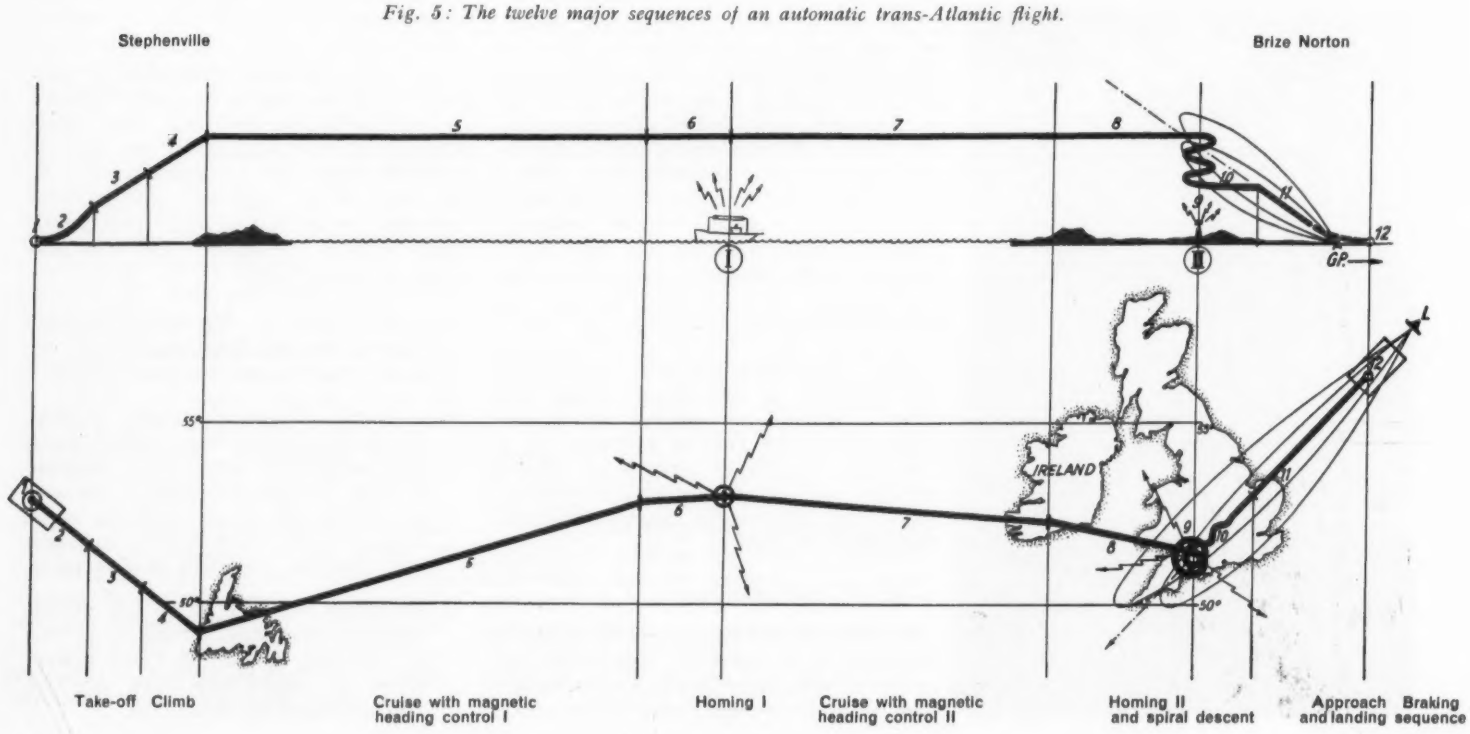
The concept of discarding glide path control at a very low altitude just before touchdown, continuing down at a pitch attitude based on a pitch gyroscope reference, has been investigated. In this case the rate of descent at touchdown is, of course, a variable which is a function of the loading, air speed, and engine thrust. Many pilots faced with an instrument landing will seek a constant rate of descent type of control in the final stages of the landing, and this type of control has been tried in conjunction with the Automatic Flight Controller. The touchdown takes place with the aircraft descending at some finite variable vertical velocity, which under low visibility conditions makes it wholly unreliable as an acceptable method of automatic landing.

Evaluation of another method of decreasing the vertical velocity at touchdown is being conducted at the present time ; this utilises a glide path beam that actually curves hyperbolically near the ground. However, this system increases insensitivity as the transmitter is approached, the cause being its angular coordinate nature.

If one examines closely the action of a human pilot who makes a landing under good visibility conditions, it is quickly seen that the real controlling factor in pitch during the final stages of a landing is the height above the runway. If a vertical gust or error in control displaces his aircraft from his glide path, he makes no attempt to make it land on the intersection of his previous flight path with the runway, but manœuvres the aircraft to take a rate of descent more or less proportional to his new height, thus landing, not on a particular point on the runway, but between certain limits which are determined

[1] In the automatic trans-Atlantic flight of the C-54, a mobile glide path transmitter was used in order to control the flare-out on landing. The author shows, however, that automatic flare-out is also feasible.—Ed.

Fig. 5: The twelve major sequences of an automatic trans-Atlantic flight.



by the configuration of the vertical gusts, and by his judgment.

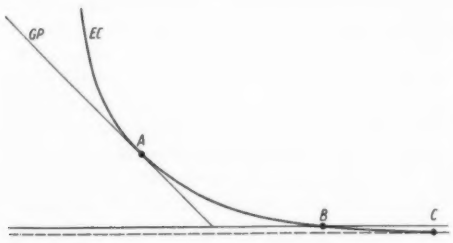
It has long since been proved by actual measurement that experienced pilots will, on landing, control their aircraft so that the vertical velocity is directly proportional to their absolute height. Expressed in a mathematical equation the relationship is:

$$dh/dt + k.h = 0$$

which is an exponential relationship between vertical velocity and height. Using a radio altimeter and a suitable differentiating computer, and based on the above equation, successful manual landings have been made in England by the Royal Air Force with the hooded pilots controlling the aircraft in pitch. An unbalance in the height reading of the absolute altimeter is made so that the exponential path intersects the runway at some finite distance from the start. (Figure 6.) The All-Weather Flying Division has adopted this system as the basic method of automatic landing by utilising the instrument fixed beam glide path ; and at an altitude, sensed electronically, when the rate of descent and height are zero, the pitch attitude of the aircraft is varied automatically so as to satisfy the exponential equation. Preliminary results indicate that reliable touchdowns can be made with the vertical velocity at touchdown less than 100 ft./min. It must be remembered that the basic equipment for this system is an altimeter whose accuracy is of the order of six feet, and whose output is further not a smooth function of the height, but varies in discrete steps. It is believed that the results of this type of automatic control for landing will show that an altimeter will be required whose accuracy is of the order of two feet, and whose output will permit measurement of vertical velocity within one foot per second.

The attendant problems of automatically controlled landings are: that skid turn control must be used in the final phase of landing, and that landing under cross-wind conditions necessitates the removal of the " crab " angle at some arbitrary altitude before touchdown. Further, it has been determined that automatic nose-wheel steering is required to prevent the aircraft from leaving the runway laterally under cross-wind conditions. Prototype equipments for the automatic control of the above functions have been designed and are under development under the present programme at the All-Weather Flying Division.

View of port side of cockpit. On the left is the pedestal controller for the automatic pilot. In the centre of the steering wheel is an over-riding engine control that allows the pilot to operate the four engines manually. This dial is calibrated in manifold pressure and r.p.m.



GP = Glide Path EC = Exponential Curve

Fig. 6 : Flare-out prior to touch down ; decreasing speed of descent. Aircraft leaves glide path beam at the point A, *where its height fulfils the exponential curve equation* $dh/dt + k.h = 0$. *Touchdown is normally at* B. *If a vertical gust or piloting error causes a gain in height, then the touchdown will be made at* C.

In the secondary phase of automatic navigation development, the " dead reckoning " nature of the navigation control used in the present Automatic Flight Controller is discarded in favour of a system that furnishes ground reference coordinates. The omni-directional VHF radio range and associated distance-measuring radar is included in a programme of development of an arbitrary course computer that permits pre-selection of a ground track by electronically comparing the error in position from a desired track to the position of the aircraft as determined by the omni-directional radio and distance measuring equipment. The parameters of the arbitrary course computer are pre-selected prior to the flight and applied as a function of the position of the Master Sequence Selector, so as to fly a prescribed ground track with a series of ground stations. Associated with the airborne computer equipment is a Time of Arrival Computer, that regulates air speed according to the rate of change in ground speed error, so as to cause the aircraft position to be related to specific preselected times. It can easily be seen that, with the completion of this development, scheduling of aircraft that are under automatic control can be initiated. The spacing, both in time and laterally, will of course be a function of the overall accuracy of the co-ordinate system and the airborne computer accuracy ; and in order to obtain more accurate coordinate systems for navigational reference, investigation of directional and distance-measuring techniques is being conducted in the 5,000 megacycle region. To complete the picture of the current development of equipment for automatic aircraft control, improved engine control systems have been designed and are in the process of development ; a concerted programme of research and investigation, that is nation-wide, is now under way to determine the guiding principles for an integrated aircraft control system and the implementation of this system by an orderly development of equipment that will allow successive portions to be utilised as they become available. The ultimate goal is the specification, fabrication, and production of an aircraft control system capable of handling aircraft in high densities during all weather conditions.

In summary, the development of automatic aircraft control systems and the attendant component sub-controls, takes its place in the overall scheme of producing a new technique in aircraft control, as the agency that freezes into practicality the proposed methods of control, and opens the doors to the promulgation of highly accurate and complex aircraft control systems by the wide-spread use of automatic electronic controls.

Limits of Economy in Commercial Flying

" Engineers are not there to build beautiful machines ; engineers are there to earn money." This was the introduction to an article on the ATA Method of Computing Flying Costs, which appeared some months ago in INTERAVIA REVIEW.[1] The writer would now like to enlarge upon this sentence by adding " ... and to show the maximum amount that can be earned." Namely, the engineer must know what is technically and therefore economically possible. And to present the limits of economy as they apply to commercial flying is the aim of the present article.

The factors which influence the commercial aspects of an aircraft are the payload, the range, and the fixed and variable costs. As active item brought by the aircraft into the business, it is usual to give the transport work, which is the product of the payload G_P and the trip length R. The passive items comprise the costs K, which are in given dependence of many factors. The part which embraces the pure operational costs is easily obtained by the ATA method. It has become a rule to judge the commercial value of an aircraft according to the ratio between the afore-mentioned passive items and active items. Of equal significance are the costs in dollars, or some other currency, per weight unit of payload and kilometre, or mile.

As the first step of our investigation let us consider only the magnitude of the transport work, as this represents an important aspect of the entire case and also has a certain amount of importance for such cases where one would only be concerned with the transport work and not with the costs—*e.g.* when flying in wartime.

Let us therefore assume that an aircraft has a take-off weight of 10 tonnes. This weight is dictated by strength and performance requirements, and officially limited by national aviation authorities. It represents the sum of the constructional and disposable loads, and can be regarded as constant for a given type of aircraft. For our purpose, it will be convenient to divide the take-off weight G_O into three parts : first, the payload G_P; second, the weight of fuel G_F necessary for reaching the destination ; and third, the tare weight G_T, which embraces all the other weights, thus crew, fuel reserves, and so forth.

Payload and fuel weight add up to give the disposable load, which amounts to a certain percentage of the take-off weight, which we shall assume in our case to be 35 per cent., *i.e.* 3.5 tonnes. The length of the attainable range is now governed by the sub-division of the disposable load into payload and fuel. Fig. 1 presents these relations for the case in which the aircraft always flies at that speed and on that engine power giving the maximum range. Apart from the sub-division of the disposable load,

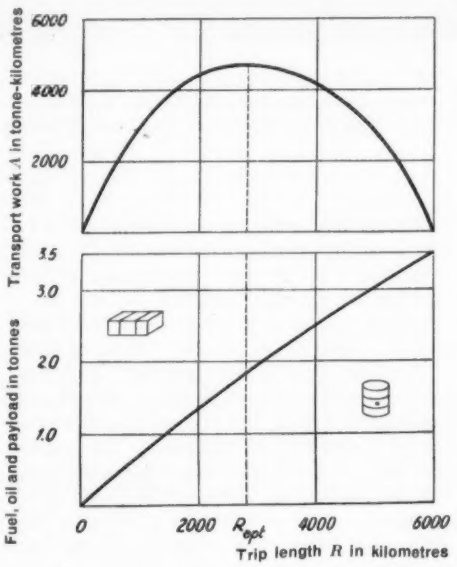


Fig. 1 : Transport work A *and distribution of the disposable load, in dependence of the trip length* R, *for an aircraft of 10 tonnes take-off weight, 3.5 tonnes disposable load and 6,000 kilometres maximum range*

the upper part of Fig. 1 also shows the magnitude of the transport work in function of the trip length. Because the trip length is equal to zero at maximum payload, and, conversely, no payload can be carried if the trip length is equal to maximum, the transport work, too, as a product of the payload and trip length, amounts to zero under these conditions. In between, it attains a definite maximum.

The more exact mathematical examination of this value shows that the optimum trip length and the optimum payload part (payload part is the ratio of payload to take-off weight) is dependent only on the ratio of the tare weight to the take-off weight, thus on the tare weight part. It may furthermore be seen that the optimum weight is a little less than half the maximum trip length.

Thus for the tare weight of 65 per cent. chosen for the above example, we obtain an optimum trip length amounting to 47.2 per cent. of maximum. In a similar manner, the optimum payload then amounts to a little less than half of the maximum payload. For this, the mathematical dependence of the optimum payload on the tare weight is exactly the same as that of the optimum trip length, so that, in our example, also the optimum payload amounts to 47.2 per cent. of the disposable load. For the rest, the dependence on the tare weight is relatively small. For the remaining tare weight parts, of 50 to 70 per cent. of the take-off weight, we obtain for the optimum trip length and payload 48 to 46.5 per cent. of the maximum values.

For this fact we can derive a simple calculation rule for ascertaining the maximum transport work. As we can easily infer from the above, the maximum transport work is on the average 0.75 times the disposable load multiplied by 0.47 times the maximum trip length, thus 0.22 times or 22 per cent. of the transport work which we obtain from multiplying the entire disposable load by the maximum trip length. The transport work thus obtained we shall call gross work, in apposition to the net work, which represents the work attainable in reality. In accordance with the small dependence of the optimum payload and trip length parts on the tare weight parts, the ratio of the net work to the gross work also fluctuates only very little. With the above-assumed tare weight parts of 50 to 70 per cent., this ratio lies between 23 and 21.4 per cent., so that we can always count on an average of 22 per cent. Thus the ratio between the net work and the gross work is dependent practically only on the trip length, and cannot exceed 22 per cent.

Thus besides maintaining a given trip length, another requirement helping to obtain large amounts of transport work is to make the gross work as great as possible. Its magnitude is dictated by the size of the disposable load and the maximum range which is attained due to a high degree of airscrew efficiency, low specific fuel consumption, and low airframe drag cœfficient. Since large aircraft usually take on large disposable loads, it is logical that they do large amounts of transport work.

As we have seen, the gross work is in a way the yardstick for the transport work. It indicates the order of its magnitude and is,

[1] Cf. "INTERAVIA, Review of World Aviation," No. 11, Vol. II, p. 27-35.

as far as the transport work is concerned, simultaneously indicative of the quality of an aircraft. This latter characteristic appears particularly clear from the influence of the tare weight on the gross weight. Thus, for instance, with a tare weight part of 50 per cent., the gross work is more than three times as great as in the case of a tare weight part of 70 per cent. In our numerical example we can execute the following calculation : if the tare weight is reduced from 6.5 to 6.2 tonnes, thus by about 5 per cent., the dispos able load increases from 3.5 to 3.8 tonnes, and the maximum trip length from 6,000 to 6,630 kilometres ; in this way the gross work augments from 3.5 to 6,000 = 21,000 tonne-kms. to $3.8 \times 6{,}630 = 25{,}200$ tonne-kms., thus by 20 per cent., and the maximum net work augments at practically the same rate. The old call for low tare weight is therefore particularly sharply emphasised in this instance.

We shall now go over to the economic aspects, as such. Since this is a very general investigation, we need not begin by making any special prerequisites as regards season or itinerary, but shall merely state that our aircraft flies within the period for which we wish to define its commercial value, thus during one year, for example, n times over the same route R. During this time, therefore, it does the transport work $n \times G_P \times R$.

The costs incurred during this period can be divided into three distinct groups.

The first group covers the fixed costs, *e.g.* airframe and engine depreciation, wages, and suchlike, which do not depend on how often or how far the aircraft flies, but also arise if the machine stands still in its hangar. We shall call these costs K_1.

The next group covers those costs which are strictly dependent on the number of flights carried out. For example, these costs can arise from certain maintenance work necessary after each flight, or owing to certain fees. If we call the costs of a single flight k_2, then at the end of our calculation period we can set $K_2 = n \times k_2$ as the total of these costs.

The third group of costs represents the expenses connected with the number of kilometres flown. Of course, they can also be calculated from the flying speed and the flying hours. For this investigation, however, it is more convenient to take the costs per unit of trip length, this by making $K_3 = n \times k_3 \times R$. Thus the factor k_3 signifies the costs per kilometre and, under certain circumstances, can be dependent on the speed. K_3 includes the cost of maintenance and overhaul, fuel and oil, hourly and distance supplements for crew members, and so forth. The sum of all costs is therefore :—

$$K_1 + K_2 + K_3 = K_1 + (n \cdot k_2) + (n \cdot k_3) \cdot R$$

At this point we can interpolate a comparison with the ATA compution method, in which practically all the costs are based on the trip length. In the case of such costs that are by nature independent of the trip length, as for instance the depreciation, the trip length dependence is introduced by assuming a certain season and by taking the speed into account. In calculating the costs of a project, it is absolutely impossible to act otherwise, and it is simultaneously the most practical method. In this instance, meanwhile, we have, instead of the season and speed, the operational frequency n in conjunction with the trip length R. When sub-dividing the costs according to the above scheme—whereby the cost ascertainment should extend beyond the pure operating costs—attention should be paid in using the numerical data and the ATA method to find out in which of the three cost groups the costs mentioned in the ATA method belong by nature.

The costs per tonne-km., which we shall briefly call transport costs, are then :—

$$C = \frac{K_1 + (n \cdot k_2) + (n \cdot k_3) \cdot R}{n \cdot G_P \cdot R}$$

Before examining this formula we shall first note the following facts. We can see that the size of the aircraft has an influence on the transport work. In calculating the costs per tonne-km. of transport work, however, this influence is no longer so prominent, since the individual costs are also in some way or other dependent on the size of the aircraft. Though we cannot speak of a direct ratio it is all the same evident that the individual costs must augment as the size of the aircraft increases. Thus it may be seen that the most economical size of aircraft is that for which the sum of all cost groups per tonne gross weight is smallest, *i.e.* that for instance the purchase price, the maintenance costs, etc., per tonne gross weight, should be small. Meanwhile, however, this does not necessarily imply that these conditions are valid for giant-size aircraft.

In view of the large number of variable factors, it is rather difficult to present our cost equation graphically. We shall therefore begin with an example in which the separate cost factors and the tare weight are given as constants, leaving open only the operational frequency n and the trip length R. Fig. 2 shows the curves of equal transport costs plotted in function of n and R, whereby the cost level was chosen as near as possible to actual conditions. In order to cover all aspects with sufficient accuracy, the curves are plotted on a logarithmic scale. With given cost factors, a graph of this sort embraces every possible operational condition to which an aircraft can be subjected. For this reason, it could very well be called an operational cost chart. The upper part of the chart is limited by a line which is given by the eventual annual trip length. Namely, for a given trip length R, the operational frequency cannot be made arbitrarily high. It must be borne in mind that the hours available during the period of computation can only be used to a certain percentage as flying hours, so that the trip length attainable during the same period is also limited. This annual trip length, R_y, divided by the distance R covered in each separate flight, is equal to the operational frequency n.

On the right the chart is limited by the maximum trip length attainable on each separate flight, which is reached when the entire disposable load consists of fuel. The nearer this maximum distance is approached, the closer together come the curves of the transport costs, attaining infinity at the maximum distance, because the payload and, consequently, also the transport work, become equal to zero.

For the purpose of investigating the transport costs more closely, we can choose between three different manners of considering the problem ; these represent practical cases and will show different possibilities of attaining the lowest transport costs.

In the first case, the aircraft has to fly a certain route, but the operational frequency is not specified. This condition is plotted in the chart as a vertical line (line *a*) on a level with the selected trip length. In this way smaller transport costs are attained as the operational frequency increases, up to a point where the annual trip length is reached and these costs cannot be reduced further. In order to obtain small transport costs, in this case we must have the aircraft fly as frequently as possible.

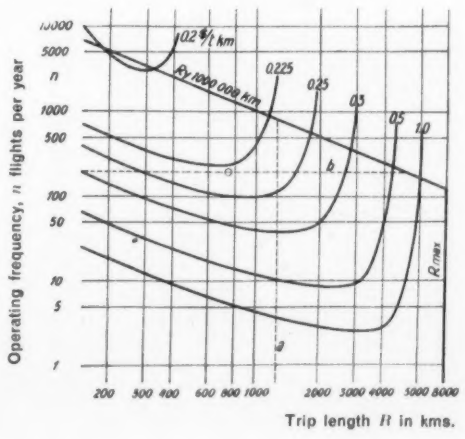
In the second case the conditions are very much different. Here the operational frequency should be given, and in the present example we shall assume a schedule of one flight each day. The length of the trip must remain open. In the chart this case is presented by the horizontal line *b*. As can be seen, a minimum amount of transport costs is attained for a definite trip length. Exact mathematical investigation shows that the optimum trip length, apart from the tare weight part, is only dependent on a certain ratio c_1 of the cost factors. This ratio is :—

$$c_1 = \frac{k_1 + (n \cdot k_2)}{n \cdot k_3 \cdot R_0}$$

whereby R_0 is the characteristic trip length for the specific aircraft, amounting to about 15,000 km. Fig. 3 shows the optimum trip length and the payload plotted in function of the cost ratio c_1.

The optimum trip length displaces with increasing cost ratio towards a limit value which is exactly the same as the value found in the sole investigation of the transport work. Logically, the same applies to the optimum payload, which is also plotted in Fig. 2. We may point out further that the cost ratio c_1 can be influenced by the operational frequency, in that the cost ratio, and consequently also the optimum trip length, diminish as the operational frequency increases. Meanwhile, the cost ratio can change during the life duration of an aircraft, whereby the tendency is that c_1 decreases

Fig. 2 : Curves of equal transport costs, $/tonne-km., in dependence of the operational frequency and the trip length R, for an aircraft flying an annual distance $R_y = 1{,}000{,}000$ kms. and a maximum trip length $R_{max} = 8{,}000$ kms.



in view of probably decreasing depreciation and insurance costs as the maintenance costs increase. In this way the minimum transport costs are obtained with short trip lengths.

Finally, we might assume the case where the aircraft covers a given total trip length during the computation period, a trip length which, as we have seen, cannot exceed the annual trip length R_y. Thus we move along the upper limit line of the chart. Here, too, we can fix a trip length for which the transport costs assume a minimum value. As in the preceding case, this optimum trip length is again dependent on the tare weight and a cost ratio c_2 which would be the following :–

$$c_2 = \frac{K_1 + (k_3 \cdot R_y)}{k_2 \cdot \frac{R_y}{R_0}}$$

In the same manner as in Fig. 3, Fig. 4 shows the optimum trip length and the payload versus the cost ratio c_2. In the normal course of events, the cost ratio c_2 is very high, in view of the low value of k_2, so that, as Fig. 4 shows, the optimum trip length is very small.

As already mentioned, the optimum trip lengths are dependent not only on the cost ratios, but also on the tare weight part. The inter-relation is such that, with a smaller tare weight part, the optimum trip lengths become longer and the optimum payloads, in proportion to the possible maximum values, become smaller. For the rest, there is of course a dependence between transport costs and tare weight part, which is mainly due to the variation in the amount of transport work, since we might easily assume a case where the separate costs are not influenced by the tare weight part. According to how the case presents itself, we attain different degrees of decrease in transport costs as the tare weight part decreases. As a rule, this decrease corresponds to the attainable increase in payload, though in many cases, particularly if the trip length is great, it exceeds this value.

The general consideration of the transport costs shows, therefore, that according to the nature of the operation, there is always a possibility of reducing the transport costs to minimum values. These minimum values are attained either with relatively short trip lengths or with very high operational frequencies. For the present, long trip lengths are still expensive.

Our considerations would not be complete if we did not mention in conclusion the possibilities of improving the economy in civil flying apart from reducing the separate costs, this especially over long routes for which the aircraft, thanks to its speed, is well placed to conquer.

A first operational case would be primarily concerned with displacing the limit line of the annual trip length towards higher values. This can be attained on the one hand by fuller exploitation of the available flight hours, and on the other hand by raising the flying speed. Both measures may of course not be accompanied by such an increase of the individual costs that only small gains would be achieved.

In the second operational case, one would endeavour to increase the cost ratio c_1, *i.e.* a special effort would have to be made to reduce the costs per unit of trip length, in order to increase the optimum trip length. Besides this, an increase of maximum range would be very effective, as a certain percentage increase of this trip length would entail a proportional increase of the optimum trip length.

In the third operational case, the aforementioned measures would also bring about an improvement.

Quite generally, the transport costs are reduced if the maximum range is increased. This distance can be regarded as a collective term for the economic qualities of an aircraft. It embraces constructional and aerodynamic characteristics, such as low tare or empty weight (and consequently high disposable load) and low drag, as well as engine qualities such as good airscrew efficiency and low fuel consumption. The increase in maximum trip length is represented in our chart as a displacement towards the right of the lines of equal transport costs, whereby a reduction of the costs on long trips is very discernible.

Understandably, these conditions can only be fulfilled by first-quality aircraft, which give this impression by there external aspects alone. Accordingly, we must enlarge further upon the introductory phrase and add that engineers must finally build machines which are also beautiful in order to earn money.

Dr. F. H.

[1] $R_0 = 270 \frac{\eta}{\epsilon b}$ (km), whereby η is the airscrew efficiency, ϵ is the lift/drag ratio at which the flight is carried out, and b the specific fuel consumption in gr./CV.hr.

Fig. 3: Optimum trip length R_{opt} and optimum payload $G_{P\,opt}$ in percentage of the maximum trip length R_{max} and the maximum payload $G_{P\,max}$, in dependence of the cost ratio

$$c_1 = \frac{K_1 + (n \cdot k_2)}{n \cdot k_3 \cdot R_0}$$

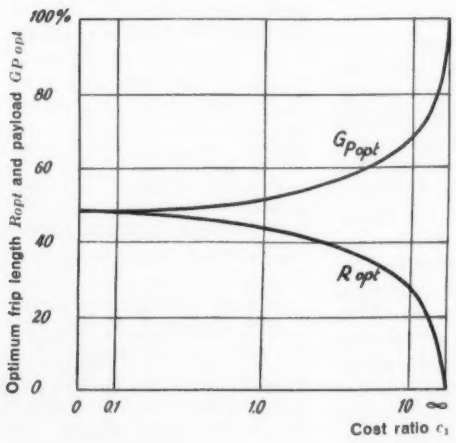
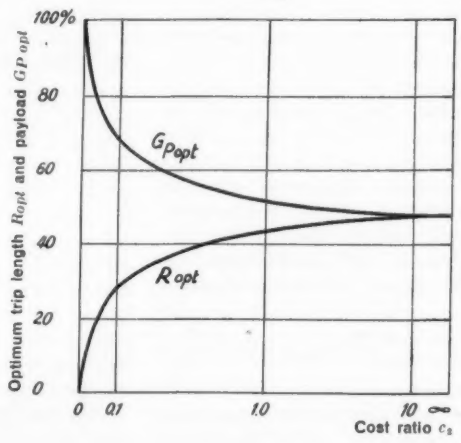


Fig. 4: Optimum trip length R_{opt} and optimum payload $G_{P\,opt}$ in percentage of the maximum trip length R_{max} and the maximum payload $G_{P\,max}$ in dependence of the cost ratio

$$c_2 = \frac{K_1 + (k_3 \cdot R_y)}{k_2 \cdot \frac{R_y}{R_0}}$$



XUM 48
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Lockheed Fire Department's fire truck ready for action.

Crash!

BY GENE GACH, HOLLYWOOD, CALIF.

Anything that moves might collide. In any form of transportation collisions are almost inevitable. Motor-boats collide. So do toboggans, aquaplanes, roller-skaters, hens and kites. Even pedestrians collide with pedestrians.

The aircraft industry, in dealing with crashes, is handicapped. The air accident is given such prominence in the public press. And for obvious reasons : gravity regaining its dominion over man — the flame and explosion — the fame of air travellers — and the relative newness of air travel.

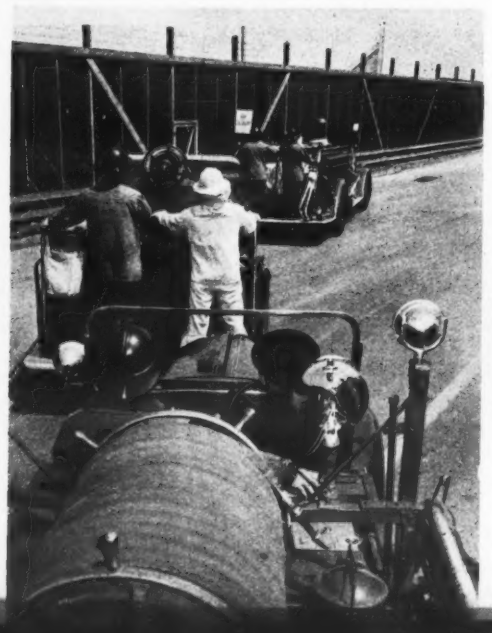
Granted, the first approach in dealing with air crashes is prevention, better planes, better training, increased safety measures.

Satisfied that it is doing all in its power to improve safety measures, and prevent accidents, the aircraft industry subsequently consults the "what-if" department.

What if there is a crash ? What should be done to save life, property ; prevent the re-occurrence of the crash ; and to minimise its effect on the public ? Obviously, if all concerned knew exactly what their responsibilities were at the time of the crash, lives, property and public good-will might be salvaged.

Based on an Interavia survey-poll of all leading United States aircraft manufacturers and airlines, we recommend that all concerned with the manufacture or operation of aircraft issue *Crash Bulletins* to personnel concerned, and that these bulletins be adapted from the following master bulletin which has been prepared for a fictitious company that not only manufactures military and commercial aircraft, but also operates its own air terminal and its own airline.

The Los Angeles Fire Department at Los Angeles Airport is alerted by the tower with the aid of two-way direct radio communication of an airplane emergency landing. With no time lost they speed to a position by the runway and stand by for action (see photo at bottom of next page).



Like this one, many crashes turn out well for occupants. Here it was not necessary for either fire or first-aid personnel to intervene ; more urgent was to clear the railway line.

1. This establishes the organisational duties of Company personnel, and the civic and service units. Emergencies have been classified into five types. Each type is identified by a signal. A directive for all units and personnel concerned when an emergency occurs is listed chronologically for each type. Comments on procedure are also included.

2. The responsibilities and duties for each Company group and individual are explained in the job description.

3. The various civic and service emergency units are described as to their equipment and capabilities. Methods of establishing communications with these groups and their procedures when alerted are also explained.

4. The emergency procedure should be well studied by all personnel concerned and a copy of the same should be kept readily available for immediate reference in the event of an emergency.

I. Emergency Classifications

A. Signal A-1

Sound — one blast from siren, at quarter-minute intervals.
Sight — tower flag will hoist A-1 flag — white.
Pending emergency at, or in the immediate vicinity (5-mile radius) of home base.

B. Signal B-2

Sound — two blasts from siren, at quarter-minute intervals.
Sight — tower flag will hoist B-2 flag — green.
Disabled or crashed aircraft at, or in the immediate vicinity of home base.

C. Signal C-3

Sound — three blasts from siren, at quarter-minute intervals.
Sight — tower flag will hoist C-3 flag — blue.
Pending emergency in a known vicinity away from the home base.

D. Signal D-4

Sound — four blasts from siren, at quarter-minute intervals.
Sight — tower flag will hoist D-4 flag — red.
Disabled or crashed aircraft in a known vicinity away from the home base.

E. Signal E-5

Sound — five blasts from siren, at quarter-minute intervals.
Sight — tower flag will hoist E-5 flag — striped.
Unheard from and/or overdue aircraft.

II. Signal A-1

A pending emergency at, or in the immediate vicinity, *i.e.*, a five to ten-mile radius of the home base.

Item 1:

The Company fire department and emergency trailer will proceed to a specified strategic location near the home base control tower and stand by.

Item 2:

The following Company emergency crews shall stand by for orders :-

1. Plant Protection
2. Ambulance Unit
3. Crash Crew
4. Flight Operation
5. Production-Emergency

Item 3:

The following Testing Division personnel shall stand by :-

1. Emergency Manager (Director of Testing Division or Deputy Manager of Testing Division)
2. Chief or Supervising Pilot
3. Assigned Flight Engineer.
4. Supervising Inspector of Testing Division.
5. Supervising Shop Manager of Testing Division.

Item 4:

The following Company personnel shall report to, and remain at their posts :-

1. Radio Operator
2. Chief Switchboard Operator
3. Flight Dispatcher
4. Emergency Pilot, Co-Pilot, Flight Engineer, Stewardess
5. Public Relations

Item 5:

The following outside groups will be alerted at the order of the Emergency Manager :-

1. Airways Traffic Control
2. Civilian Fire Departments
3. Local Police
4. Civic Airport Authorities
5. CAA Authorities
6. Military Liaison (if plane is military).

COMMENTS:

The Emergency Manager, in this type of emergency, will ascertain that :-

(a) The Supervising Pilot is standing by to relay emergency procedures to the pilot concerned upon such request, and also to advise the pilot concerned about emergency procedures relating to the operation of the aircraft in question.

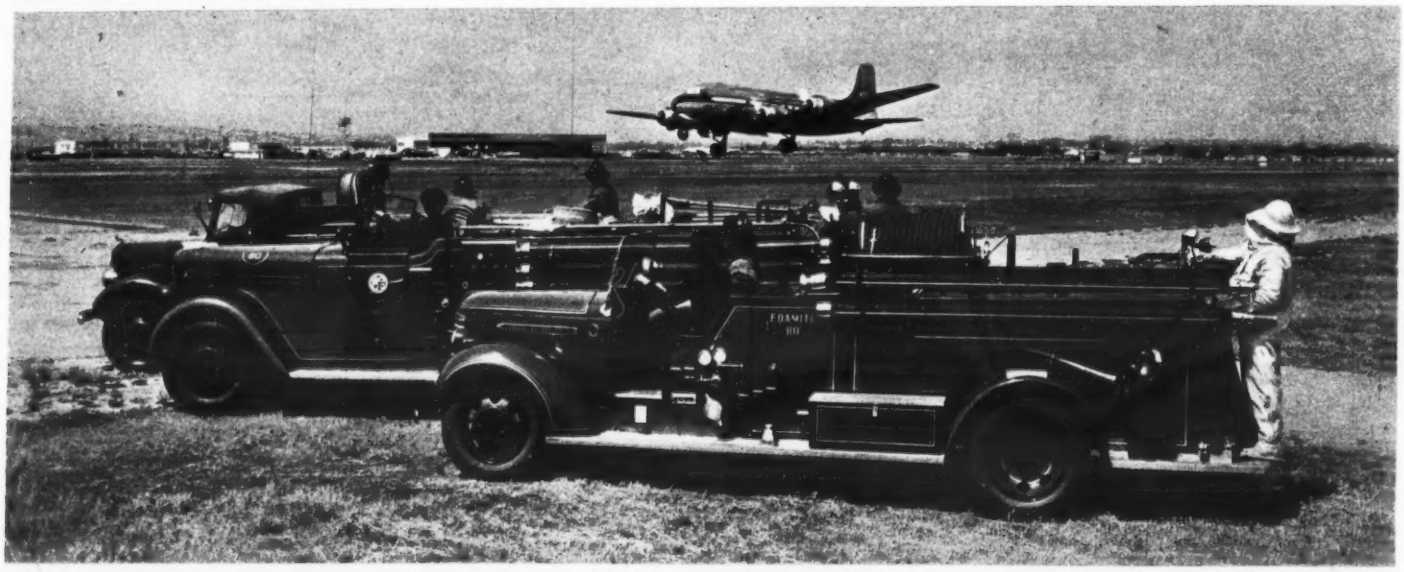
(b) The Supervising Testing Division Shop Manager has the crash crew standing by in case the aircraft becomes disabled as the result of a forced landing.

(c) The Supervising Inspector of the Testing Division has a crew standing by to inspect the aircraft, ascertain the cause of its difficulty, and report on same as soon as the aircraft is prepared by the fire department and others concerned for them to do so.

(d) One person is deputised to act in his capacity in lieu of his presence at Flying Operations or at the scene of the emergency.

(d) One of the communications personnel is directed

Signal A-1 : A pending emergency has been radioed from the tower. The fire and emergency trucks have rushed to this standby position next to the runway, ready, with the latest and most efficient equipment available, to go into action.



to alert emergency fire, police, and service units in the area concerned.

SIGNAL A-1 EMERGENCY CONTACTS

Fire Departments

(List phone numbers of all fire departments within a 30-mile radius.)

Police Departments

(List phone numbers of all police departments within a 30-mile radius.)

Ambulance

(List phone numbers of all ambulances within a 30-mile radius.)

Hospital

(List phone numbers of all hospitals within a 30-mile radius.)

Civil Air Patrol

(List phone numbers of all Civil Air Patrols within a 30-mile radius.)

III. Signal B-2

A disabled or crashed aircraft at, or in the immediate vicinity of the home base.

Item 1 :

The following Company emergency crews will proceed to the scene of the accident (whether notified by autocall signal, siren, flag, phone or any other means) :-

1. Fire Department
2. Plant Protection
3. Ambulance Unit
4. Crash Crew
5. Flight Control
6. Production-Emergency

Item 2 :

The following personnel will proceed to the accident area :-

1. Emergency Manager (or his deputy)
2. Supervising Pilot
3. Assigned Flight Engineer
4. Supervising Inspector of Testing Division
5. Shop Supervisor of Testing Division
6. Public Relations

Item 3 :

The following Company personnel shall stand by at their posts :-

1. Flight Dispatcher
2. Radio Operator
3. Switchboard Operator
4. Public Relations Assistant

Item 4 :

The following outside groups will be alerted on the orders of the Emergency Manager :-

1. Airways Traffic Control
2. CAA Authorities
3. Airport Management
4. Civilian Fire Department
5. Local Police
6. Military Liaison (if plane is military).

COMMENTS :

The Emergency Manager in this type of emergency will ascertain that :-

(a) Emergency crews perform their duties as described herein.

(b) Preparations are made for necessary hospitalisation of occupants.

(c) Co-ordination is established between the Company emergency crews and the various civic emergency crews such as local fire departments, police, etc.

(d) Preparations for the removal or complete "freezing" of the disabled aircraft or wreckage are made.

(e) Supervising Pilot, Flight Engineer and Inspector determine the cause of the accident, if possible, and report on same.

(f) Passengers are relayed to plane alerted by 4, Item 4, Signal A-1.

SIGNAL B-2 EMERGENCY CONTACTS

(List phone numbers of all fire departments, police departments, ambulances, CAP, hospitals within a 5-mile radius.)

IV. Signal C-3

A pending emergency in a known vicinity away from the home base.

Item 1 :

Following Company personnel will report to and remain at their posts :-

1. Radio Operator
2. Chief Switchboard Operator
3. Dispatcher

Item 2 :

Following Company crews will stand by for orders :-

1. Fire Department
2. Plant Protection
3. Ambulance Unit
4. Crash Crew
5. Production-Emergency

Item 3 :

Following Company personnel will stand by :-

1. Emergency Manager
2. Supervising Pilot
3. Supervising Inspector of Testing Division
4. Shop Manager of Testing Division
5. Public Relations

Item 4 :

Following outside groups will be alerted in the area concerned at the order of the Emergency Manager :-

1. Airport Control Tower

One of Northrop Aircraft's four 49,000-lb. fire trucks, which sprays carbon dioxide at a pressure of 125 lb./sq. in.; a hot high-octane blaze can be snuffed in a matter of seconds. In addition to 6,000 lbs. of carbon dioxide, the truck also carries a 500-gallon supply of water, which is sprayed through fog nozzles to protect equipment and personnel working in close proximity to fires. There are altogether fourteen outlets for combatting fire with either carbon dioxide or water, and they may be directed by operators working inside the cab.

Decked in an asbestos suit, this fireman is prepared to enter the fiercest fire and make a rescue.

2. Local Fire Department
3. Local Police
4. Airport Management
5. Military Facilities (Army, Navy, Coast Guard, AAF, Marine)
6. Hospitals and Ambulances
7. Forest Rangers.

COMMENTS :

The Emergency Manager, in this type of emergency, will ascertain that :-

(a) Contact is established between Company communication facilities and the airport control tower, or other stations communicating with the aircraft concerned in the emergency, if possible.

(b) Company emergency crews are standing by and are ready to proceed to the area of the pending emergency and decide whether the Company emergency units will need to go into action or whether the units available in the area are capable of handling the emergency.

(c) The Supervising Pilot has recalled necessary Company aircraft engaged in flight to regain the home base, or field nearest scene of known vicinity.

(d) The Supervising Pilot is standing by to broadcast emergency procedures to the pilot concerned regarding the operation of the aircraft in question.

(e) Military liaison is established if the plane is military.

(f) Alternate transportation is arranged for relay of passengers.

SIGNAL C-3 EMERGENCY CONTACTS

List *all* phone numbers of fire departments, police, ambulance, hospital, military service units, forest patrol, CAP, and CAA in the major areas where Company aircraft operate.

V. Signal D-4

A disabled or crashed aircraft in a known vicinity away from the home base.

Item 1 :

The following Company crews will proceed to the emergency area upon receiving such an order from the Emergency Manager :-

1. Fire Department
2. Plant Protection
3. Ambulance Unit
4. Crash Crew
5. Production-Emergency

Item 2 :

The following Company personnel will proceed to the emergency area upon receiving such an order from the Emergency Manager :-

1. Supervising Pilot
2. Supervising Inspector
3. Shop Supervisor
4. Emergency Manager
5. Public Relations

The Emergency Manager will either proceed to the emergency area, or remain at the operations base at his discretion. In any event, he will deputise a person in his absence from either location to act in his capacity.

Item 3 :

The following Company personnel will stand by at their respective posts :-

1. Flight Dispatcher
2. Radio Operator
3. Switchboard Operator.

COMMENTS :

The Emergency Manager in this type of emergency will ascertain that :-

(a) Emergency and rescue units (civil, private and military) are alerted and report to the scene of the emergency area.

(b) Whether Company emergency units will participate in the emergency.

(c) In the event Company units do participate in the emergency, the Supervising Pilot has recalled all necessary Company aircraft in flight to the home base.

(d) Arrangements are made for the hospitalisation of passengers and personnel as necessary.

(e) The Supervising Pilot, assigned Flight Engineer, and Supervising Inspector are prepared to proceed to the scene of the emergency area and ascertain the cause of the emergency and prepare a written report on same.

(f) Communications between the emergency area and the home base are established, if possible.

(g) Military liaison established if plane is military.

(h) Alternate transportation is arranged to relay passengers.

SIGNAL D-4 EMERGENCY CONTACTS

The Emergency Manager will keep on file a complete list of *all* fire department, police, ambulance, hospital, military service units, forest patrols, CAP, CAA and, upon establishing scene of accident, issue local phone numbers to all concerned.

VI. Signal E-5

Unheard from and/or overdue aircraft.

Item 1 :

Alert all Company emergency personnel to stand by for orders.

Item 2 :

Emergency Manager will request activation of outside rescue units to search the area where the aircraft was last reported.

COMMENTS :

The Emergency Manager, in this type of emergency, will ascertain that :-

(a) All outside groups, emergency and rescue units in the approximate area have received information concerning the emergency and are acting upon same.

(b) Preparation of Company search crews operating Company aircraft has been organised.

(c) All communication facilities are available for emergency communications.

(d) Military liaison is notified if plane is military.

VII. Emergency Duties and Procedure

A. *Fire Department Operation*

The Fire Department will immediately advise the Flight Operations Dispatch Office of any equipment breakdown, and when responding to an emergency they will always be suitably equipped and ready to perform rescue work as well as fire fighting. When on Flight Operations duty the emergency radio frequency designated for such use should always be monitored to receive any emergency contact necessary.

The Emergency Officer in charge of firemen will direct the Company Crash Crew in rescue operations and ascertain that all precautions have been taken to prevent a fire outbreak when rescuing occupants from the crashed or disabled aircraft. Also, he will keep the Emergency Manager informed of the progress during an emergency and will co-operate with and direct civil and military fire fighting units coping with the emergency.

B. *Plant Protection*

Before proceeding to an emergency, the officer in charge of the emergency crew will determine as closely as possible the exact location of the pending emergency or the wreckage.

Upon arriving at the scene of the emergency or accident, the officer in charge will set up a restricted area. A road leading to the area will be patrolled and kept open for Emergency Units only.

Questions regarding methods of emergency and accident procedure will be settled by the officer in charge in lieu of a member of Flight Operations Management not being present.

Plant Protection shall notify the Insurance Manager of all accidents.

C. *Medical Unit*

The Supervising Doctor will ascertain that the Medical Crew, when standing by for emergency duty, are suitably prepared and equipped to proceed to the emergency area. At the scene of the accident, the Supervising Doctor will ascertain from the Fire Chief that the wreckage is safe for first aid and rescue procedure. The Supervising Doctor will advise the Crash Crew and Fire Chief when necessary, concerning the method whereby the structure will be altered in order to proceed with first aid and rescue.

D. *Crash Crew — Production-Emergency*

The Shop Supervisor of the Testing Division will ascertain that Crash Crew and Foremen, when standing by for emergency duty, are suitably prepared and equipped to proceed to the emergency area. It is the Supervisor's responsibility to dispatch a Foreman for the Crash Crew who is experienced in service, maintenance, and overhaul operations on the Company aircraft concerned in the emergency.

The Foreman of the Crash Crew will be responsible for the Crash Crew personnel. The Foreman will understand his line of authority in rescue procedure in that he will be under the supervision of the Fire Officer in charge. He will advise the Fire Chief when the airplane is safe for rescue operations.

In making the airplane as safe as possible for trapped occupants, the Crash Crew will be advised by Production-Emergency on such procedures as disconnecting electrical circuits, plugging fuel lines, etc. Rescue exits must be established ; parts and jagged metal

Fighting fire with carbon dioxide.

trapping or endangering the occupants must be cut away.

The Testing Division will be responsible for obtaining all necessary photographs.

E. *Inspection*

The Supervising Inspector from the Testing Division and his personnel will investigate the structure and equipment of the aircraft involved, and if possible determine the cause of the accident. They will proceed with this investigation as soon as the emergency units have accomplished their respective tasks, but before the aircraft is altered in any way other than necessary for removing the occupants.

They will co-ordinate their activities with military, CAA, local, and other investigating groups.

F. *Switchboard Operator*

1. Upon being advised of an aircraft emergency, the Switchboard Operator shall immediately transmit the call to the Emergency Manager and then to Plant Protection.

2. Plant Protection shall then immediately notify :

(a) Company Fire Department (who will blow proper sirens),
(b) Flight Dispatcher's Office (who will raise proper flag),
(c) Chief Pilot's Office,
(d) Supervising Pilot's Office,
(e) Radio Communications Office,
(f) Public Relations.

3. Upon being advised by the Emergency Manager or one of the emergency unit groups of the class of emergency, the Plant Protection Switchboard Operator shall immediately broadcast same over the loud speaker (repeated three times) in the following manner : " Attention — Signal (give noted number). "

4. In any emergency the Switchboard Operator shall immediately notify the Chief Switchboard Operator, who will instruct all operators to have the necessary lines cleared to handle emergency communications only. (In the event that notification of the emergency comes direct to the Plant Protection Switchboard, they shall notify the Chief Switchboard Operator to have all necessary lines cleared.)

G. *Flight Dispatcher*

1. All verbal, written, and telephone messages will be handled by the assigned dispatcher only.

2. Only those designated by the Emergency Manager shall enter the operations area.

3. Upon being advised of an emergency takes the following action :

(a) Notify Emergency Units,
(b) Call Crash Crew and Production-Emergency,
(c) Call Emergency Manager's Office,
(d) Call Chief Pilot's Office,
(e) Call Supervising Pilot's Office,
(f) Call Radio Communications Office.

H. *Radio Communications*

All communications will be handled by assigned operators only. Only those designated by the Emergency Manager shall enter the communications area. Advise radio maintenance personnel to stand by in case repair or servicing is necessary to the emergency. If the Dispatcher is not available at the time an emergency occurs, the Radio Operator will perform emergency notification duties by advising Management in the following order :

(a) Airport Tower,
(b) Company Tower,
(c) Supervising Pilot's Office,
(d) Plant Protection.

I. *Pilot's Emergency Procedure*

If possible, describe emergency details via radio to Company station, or any station maintaining any transmitting frequency available in the aircraft. When communicating with Control Tower ask operator to notify Company Flight Operations. Upon effecting a landing, either in the aircraft or by parachute, the pilot shall proceed to the nearest means of communication as soon as he is able, and advise Company Flight Operations concerning his status and that of the occupants. If all occupants effect a landing by parachute and are separated upon landing, it will be each individual's responsibility to communicate his status to the Company Flight Operations as soon as he is able.

When landing an aircraft in an emergency, pilots will, if possible, park same in a manner whereby it will be accessible to fire fighting units and away from other aircraft or buildings.

The pilot will also report the condition and position of the aircraft, if possible.

If the landing is other than normal, the pilot and other occupants, if they are able, should request ambulance service from the nearest communications available. The pilot and all other occupants, if they are able, and not in dire emergency, should request the ambulance or conveyance to proceed to the Main Dispensary, where the Doctor in charge will make a complete physical investigation. If the extent of the injuries are such that emergency hospitalisation is necessary, then the Main Dispensary should be so advised.

VIII.
General Information

The Emergency Manager will classify the type of emergency to all personnel concerned immediately after he has been notified of the emergency.

For signals which indicate aircraft may be in distress near the sea, Navy and Coast Guard will be alerted at once (from a pre-compiled directory) through use of radio as well as phone.

For signals which indicate aircraft may be in distress near forests, Forest Rangers will be alerted at once (from a pre-compiled directory) through use of radio and phone ; and a geographically-indexed directory of licenced amateur short wave radio operators (" Hams ") will be kept by the Emergency Manager for emergency use.

The " Production-Emergency " crew, first listed under II, Item 2, 5, is in each case a carefully selected crew of designers or production men who are so intimately familiar with the structure of the particular plane in distress that they unhesitatingly offer accurate advice to the firemen and crash crew. They know, for instance, the correct way to open emergency exits, the location of the fuel tanks, the best place to chop open a fuselage for rescuing trapped personnel.

If, for example, the Company produces a jet fighter a commercial two-seater and a 50-passenger airliner, it has three different Production-Emergency crews, each familiar with a separate make of plane.

Practice fire fighting with carbon dioxide foam against a tank of blazing gasoline.

FIRE FIGHTING

Company interest in fire fighting equipment should transcend the delegation of authority to experienced hands. Fire fighting depart-

U.S. Navy training in fire fighting and cutting away rescue exits in a wreckage.

ments should be maintained on the same rigid rules that apply to the best municipal fire fighting systems. Equipment must be examined constantly. Firemen should make periodic patrols and be called out on drills under all conditions.

Carbon dioxide trucks capable of snuffing out high octane fires in a matter of seconds with CO_2 nozzles should be standard equipment. They should also have fog sprays that can keep umbrellas of fog around personnel working right in the flames. Asbestos fire fighting suits are mandatory — but useless without continual drill in donning them quickly and being able to move about in them.

In addition to a fire truck — or fire trucks — it is recommended that emergency trailers be available and located in strategic positions. Equipment for the trailers will include one steel ladder, one long shovel, two eight-pound sledge hammers, two large fire extinguishers, two small fire extinguishers, two large crowbars, two heavy tow chains, one first aid kit, two 1-gallon spout cans, one welder's mask, two stretchers, two blankets, one pair of bolt cutters, eight stakes for roping off areas, two rolls of quarter-inch rope, one grappling hook with 50-foot cable attachment, a coil of 1-inch rope, one screw driver, one wooden ladder, six pairs of asbestos gloves, one hacksaw, one 1-gallon can of gasoline, one 110-volt auxiliary power supply, an electric portable circular saw, two portable floodlights, one 25-foot J-box, one 50-foot extension cord. The auxiliary power supply is used in operating the portable saw and for night-lighting. With the saw, one man can quickly cut a hole in a fuselage.

PUBLIC RELATIONS

The public relations director is in a delicate position at crash-time. He agrees with the company officials and stockholders that it would be well to keep the whole thing out of the press. But this tendency can do more harm than good.

Writes the Publicity Director of one large California firm : " When an accident happens — and we have had them happen right here on the field — we are the very first to call the newspapers, providing we have the information ourselves. This gives them prompt coverage, accurate information, and almost invariably results in the story being ' played down ' rather than given too great a prominence.

When any company press representative is too evasive about facts, the accident immediately takes on an air of mystery. Consequently, we believe there is nothing quite as uninteresting as facts of an accident, and conversely, nothing quite as intriguing as rumours.

Except in the case of military security — in which instance the company is not free to exercise its own decisions — no restriction is placed on photographers. We would naturally, of course, discourage them from taking any gruesome pictures — though this occasion has never arisen. "

The public relations manager of a far-sighted aeronautical manufacturing company divulges two instances where unlimited co-operation with the press resulted in advantageous coverage :

" During a military airplane demonstration for military officers given here, one of our planes was put through extremely severe manoeuvres, resulting in a structural failure in flight, and requiring the pilot to parachute. The writer actually phoned the information to the local press almost before the pilot reached the ground. The result was a factual story rather than scaring headlines about a plane ' Exploding in Mid-Air. ' We got excellent treatment from the press because we gave them excellent news coverage.

On another occasion, a fighter pilot could not lower his landing gear. Police, fire fighting equipment and ambulances were called, and the press got a tip on the incident even before it came to the attention of this office. The papers called here, telling us of their interest in making pictures of the emergency landing. We co-operated with them in every way, determined from the pilot just where he was going to land, and also aided the photographers in getting advantageous positions to take the pictures. An easy, safe belly-landing was made with little damage to the aircraft and none to the pilot. All stories and pictures which appeared were in praise of the pilot's ability and the plane's rugged construction. This would probably not have been the case had we endeavoured to keep photographers from taking the pictures. "

Note that in both these instances the aircraft in trouble were military planes. How many public relations officers of other companies might have shouted " Security ! " and refused admittance to the press, when the USAF were not concerned ?

The temptation to hide behind the screen of " military reasons " or " exigencies of the Government " are many. The timid succumb. The provident rise above them. The difference often changes the balance between a friendly or a hostile press, a confident or an apprehensive public.

Another company's press representative recalls having his own photographer take photos of an accident at his field and rush the plates to the metropolitan paper. Co-operation of that calibre establishes a friendliness between the air industry and the press that cannot be measured in money.

SYNOPSIS

The details in the above bulletin may seem over-simplified. But those who followed similar " Alert Plans " during the war agree that detailed planning during ideal conditions pays off when utilised under pressure. Oral directions do not suffice, for many reasons. Personnel shifts. People forget. And excitement changes thinking.

In order that all concerned may know their exact duties, and how to fulfil them, put a CRASH BULLETIN in their hands at once.

To the many members of the Air Transport Association and the Aircraft Industries Association, who contributed so freely to this article for the benefit of the industry, the editors of this poll express appreciation and acknowledge invaluable aid.

Russian Rotary Wing Aircraft

Work on rotary wing aircraft in Russia can be traced back to the years 1910 and 1911. At that time N. E. Joukowski and his pupils B. N. Jurjew, G. K. Sabinin and V. P. Wetchinkin were busy with fundamental calculations on rotors and with constructional details. They imagined a helicopter with the rotor shaft tilted slightly forwards, which would be able to ascend vertically and also fly forwards.

It was not until many later that rotary wing aircraft actually materialised. The first were autogiros, the KASKR I and KASKR II, which were based on designs by Professors N. I Kamow and N. K. Shrzhinski ; the rotors were driven by the main engine. The KASKR I "Krasnij Inshenier" (the Red Engineer) was constructed in 1928 and flown during the two following years from the Moscow Central Airport. Subsequently, the Central Aero- and Hydrodynamic Institute (ZAHI) in Moscow constructed the two-seater 2-EA, of which the 4-EA and the A-6 developments by V. A. Kusnetzow were built in small series for the Soviet armed forces.

The A-3 two-seater, likewise developed by the ZAHI, was remarkable for a metal skin to the rotor blades and fuselage. Fitted with a Russian M-11 engine of 115 H.P., a three-blade rotor and a triple fin and rudder unit, it was exhibited in Moscow in August, 1934. Just a year beforehand, however, the A-4 model with four-blade rotor was demonstrated ; the 6-EA version used by the Soviet Army up to 1936 was exactly the same except for the undercarriage.

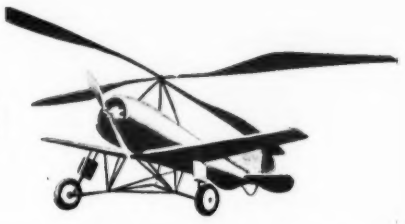
Later on Professor Kamow designed the more powerful A-7, A-7bis and A-7-3a models. The thoroughly reliable rotor drive was based on extensive vibration studies. The A-7bis was utilised for exploring and safeguarding forests in the Tien-Shan area and the A-7-3a for liaison flights behind the lines in 1941.

Two autogiros with three-blade rotors, the A-8 and A-14 developed by Kusnetzow, are not especially interesting. On the other hand, however, the A-12 single-seater built in 1937 by N. K. Shrzhinski is worth mentioning as it was powered with a 670-H.P. Wright engine.

The first real helicopter in Soviet Russia was built by the ZAHI in 1931 on the basis of data furnished by B. N. Jurjew and A. M. Isakson. Known as the 1-EA, it comprised an open framework fuselage with the power plant located in the centre, a four-blade rotor, and two four-blade anti-torque rotors located one at either extremity. With Professor A. M. Sheremukhin at the controls, it set up an altitude record of 605 metres on August 14th, 1942. During the descent, however, the pilot was no longer able to master the controls, and the 1-EA suffered considerable damage. A slightly improved new version, the 3-EA, was built immediately afterwards. Both the 1-EA and 3-EA versions carried out numerous flights at altitudes between 50 and 120 metres, lasting ten to fourteen minutes. The longest distance covered was 3 kms. and the highest speed attained was 21 km/hr. Both these helicopters were capable of ascending and descending vertically, flying horizontally and turning about their normal axis. However, they were unstable and difficult to control.

In 1934, I. P. Bratukhin designed the 5-EA helicopter. It had a six-blade rotor, three blades of which were six metres long and able to flap horizontally and vertically, whereas the three others featured smaller dimensions. The pitch change for the three small blades was accomplished through an automatic device developed by Jurjew.

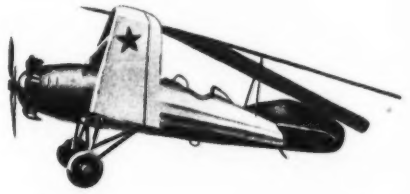
The latest Russian helicopters are the 11-EA-PV and "Omega" two-seaters designed by I. P. Bratukhin. Though its structure is very much at variance with that of the "Omega," the 11-EA-PS is said to be the experimental version of the former. The "Omega," which was displayed on the front cover of our May issue, was first demonstrated in public in 1946. It is powered with two M-11 engines, though this time of 145 H.P. They are cowled, and borne by framework outriggers, and drive three-blade rotors. The "Omega" is reported to cruise at 118 km/hr. and to be capable of attaining 180 km/hr. ; rate of climb is said to be 6 m/sec.



KASKR I and II autogiros, designed by N. I. Kamow and N. K. Shrzhinski, and built in 1928. The 110-H. P. Rhône radial engine also serves to drive the four-blade rotor.

2-EA two-seater autogiro : fixed auxiliary wing with bent-up tips, twin fin and rudder unit, 225-H. P. five-cylinder radial engine.

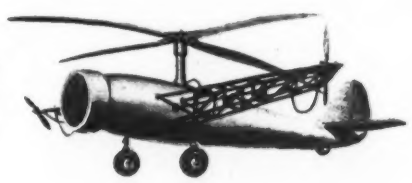
A-4 autogiro built by the ZAHI in 1933, from which was developed the 6-EA, used up to 1936 by the Soviet Army.



V. A. Kusnetzow's A-6 two-seater (1933) : upwards-folding auxiliary wing, rotor with three folding blades, 110-H. P. Russian M-11 engine.

N. I. Kamow's A-7-3a two-seater, a development of the basic A-7 type ; it no longer features the two small auxiliary fins under the elevator unit. Power plant is a 400-H.P. M-22 engine driving a metal airscrew. Gross weight between 1,975 and 2,300 kilos ; payload of 630 to 750 kilos. Horizontal speed of 40 to 220 km/hr. ; ceiling 4,000 metres. Take-off with full load after 28 metres run ; landing within 18 metres. Good controllability in horizontal flight and gliding flight up to 30 degrees.

A-12 single-seater of N. K. Shrzhinski (1937) with Wright "Cyclone" of 670 H. P. Horizontal speed of 40 to 310 km/hr. ; ceiling 7,000 metres ; take-off run 25 metres ; landing run 5-10 metres.



11-EA-PV two-seater experimental helicopter, predecessor of the twin-engined, twin-rotor "Omega." Two anti-torque rotors, rotating in the same direction, are borne by lateral outriggers. The engine is conventionally arranged in the fuselage nose.

Aerial Woolgathering

BY JEAN BÜHLER

CINTRA, PORTUGAL, MAY, 1948

We live in a small white house not far from Cintra, right on a hillside. The bay window of the study overlooks the military airfield. If my manuscript is packed with errors, it is not the fault of the typewriter: my eyes keep wandering as fighter squadrons roar away into the distance.

A few evenings ago my wife asked me to help her to disentangle her knitting wool. I held my wrists out and, from the jumble, she extracted coloured strands which, with deft movements, she formed into skeins of red, blue, white, and other shades. Whilst this was going on, we heard an aircraft flying overhead. It seemed to have come a long way, and was heading for Portela airport, just outside Lisbon. Across the dusky sky its lights traced coloured lines — like strands of coloured wool. I found myself musing that airline pilots, flying from continent to continent, must unwind truly formidable strands, of many colours, which, one day, sitting by the fireside, they will be able to knit into lasting souvenirs.

My own skein of aviation souvenirs is not so very weighty, but the strands all the same include the colours of many national flags. The first that comes to mind is dyed with the colours of Finland, blue and white. It was winter, and we flew through terrifyingly realistic masses of cotton wool. Passengers were wearing massive fur coats. Some were Finnish officers returning to Helsinki after their convalescent leave in Stockholm. It was only ten months after that memorable winter campaign which the Russian agressor had provoked. One of the young convalescents was suffering from shell shock and his right hand trembled fearfully. As we flew over the Aaland Islands his shaking finger pointed out to his comrades an ice-breaker and a troop ship, struggling through the narrow waterways. We all looked down below. The troop ship was the "Adler" from Bremen. It was taking some of General Dietl's alpine troops to Lapland. Our aircraft quickly climbed into the protective white layers of cloud. For Finland, peace was destined to last another six months.

A red strand takes my mind back to January, 1946. It was a grey night in Belgrade, and a truck was loaded with pitiful humans whom the French Government was repatriating. They were from Alsace and Lorraine, and some were still in the German uniforms which they had been forced to wear. As prisoners of the Russians and the Yugoslav partisans, those poor devils had escaped death by nothing less than a miracle: hundreds of their comrades had died in ditches alongside the roads they had been forced to cover on foot in order to reach camps and labour centres. There were also many civilians: married couples fleeing, industrialists who had been robbed of their possessions; one had been manager of a nationalised coal mine and had stayed at his post in Macedonia for four years, defending himself, sometimes with a machine gun, against Bulgarian communist bands, Chetniks, Germans, Albanians — right in the middle of that infernal political and military boiling pot which was southern Serbia during the War.

They were seated on packing cases and military sacks, waiting for the crew to de-ice the wings of a Dakota. Every half-hour the radio called Vienna, first stop on our way to Paris. We couldn't leave. The sky was a white mass; there was no ceiling at all. And the Yugoslav sentinel was patrolling warily, bayonet fixed. Despite a temperature of forty degrees below freezing point, I was moist with perspiration. The Yugoslav Government had decided

to expel the three Swiss correspondents which the newspapers, magazines and the national radio had sent out to Belgrade. One of my friends had successfully got away to southern Italy in an American aircraft. I was forced to leave Yugoslav soil for reasons which existed only in the imagination of some frustrated official. The third had gone to Greece for the elections some time beforehand. He tried to return, but was not allowed to cross the frontier. In his Belgrade hotel were his wife, dog, manuscripts, notes for a doctor dissertation, and all his personal belongings.

After considerable waiting, we took our places in the Dakota. It had been used for parachutists, so that we were all seated with our backs to the walls, facing each other. The crossing of Lake Balaton was effected in true czardas rythm. Two of the liberated P.O.W.'s, whose condition of health was pitiful, were violently sick. After some hours we landed at Schwechat aerodrome, in the Russian zone. The field was like a lake which had suddenly been frozen during a storm. Under her mantle of snow, Vienna looked like a little old woman who, having reached the limit of exhaustion, had sat down on the roadside and gone to sleep in the tempest.

The Russians trudged through the streets with their small supply sledges. We were taken to a hotel where the rooms had no windows and the beds no covers.

Never did Paris seem so wonderful to me as when we finally arrived there after that particular trip.

My next souvenir is of a sunnier clime. I was awaiting the arrival of a Ju 52 on a scorching hot morning when something rather odd occurred. A pilot, who had been told the runway was clear for taking off, stopped his machine half way along the track and returned to his point of departure. Alighting, he began vociferating his opinion of the airport personnel in terms which I dare not reproduce here. A jeep made hurriedly for the spot where the pilot maintained the runway was blocked by a tree trunk.

As it happened, however, it was not a tree trunk, but a crocodile, about twenty feet long, which had crawled out of the River Shari and chosen just that spot to interrupt its morning stroll.

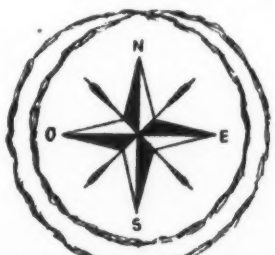
I ought to say that this took place at Fort-Lamy aerodrome, near Lake Chad, in the heart of French Equatorial Africa. On our trip, we were spared the presence of crocodiles, and the several hundred vultures disturbed by our presence were no more angry at us than the storks, cranes, herons and pelicans of the African sky.

Flying over the Dark Continent is one of the most captivating experiences one can wish for. Africa's vegetation is like a coat of many coloured stripes, which one crosses one by one when flying between north and south. Following the green and white zone of the Mediterranean is the tawny strip of immense desert ; then come the green specks interlaced by the ribbon-like rivers of the Sahel and Sudanese regions. It is there we find Fort-Lamy. Later, we enter the brushwood, and trees become gradually apparent as we approach the great equatorial forest. Below the Chad brushwood, we start supplementing our geography lesson with a short study of zoology. There goes a band of wart-hogs, the incredibly ugly wild boars peculiar to Africa ; the noise of our engines disturbs a cayman in its siesta, and the large reptile pops out from its riverside home and slips into the water. Gazelles and other antelopes leap to cover beneath the aciacias. Our most startling meeting is with three elephants. As the pilot drops the aircraft and turns around them, the otherwise quiet pachyderms start trumpetting furiously, their great ears flapping ungracefully as they make for the trees.

* * *

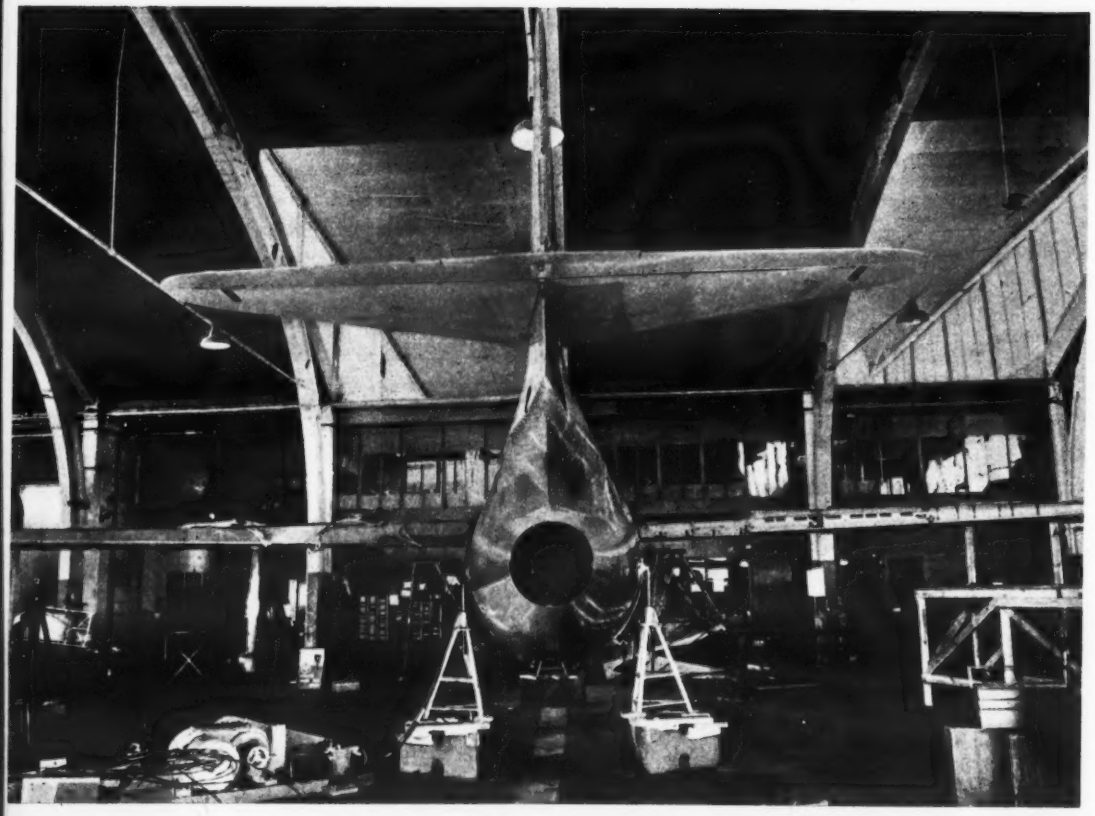
If ever you have reason to go to Africa, I can heartily recommend you to travel in an Air France Junkers over the Dakar—Niamey—Zinder—Fort-Lamy—Bangui—Brazzaville route. One line leads back from the Congo to Senegal along the Guinea Coast. This gives you a far better idea of the true Africa than a non-stop service. I flew back in a Skymaster in 24 hours and 20 minutes flying time from Leopoldville, capital of the Belgian Congo, to Paris. It was indeed a marvellous trip, seeing that we covered about 4,400 miles, but how much I regretted flying through the night, blind to the marvels of the desert below, where I had travelled for weeks on end with my Tuareg friends, leading my camel by a cord, and where I had drunk tea with the nomad tribes and slept in the sand, rolled up in my burnous.

A few more strands have lately found their way into my skeins of souvenirs — dyed with the colours of France and Portugal. Paris—Lisbon, a bridge of friendship and peace, the pleasure of jumping over frontiers, knowing that they could be links instead of barriers. And the joy of landing at the gateway to the Atlantic, right near to the port which, throughout the suffocation of war, was the only lung Europe could boast ; right near to the vast ocean which brought us the maritime and aerial fleets of liberty.



J 29

Sweden in the Forefront of Jet Fighter Design



A country today wishing to defend herself in the air must have jet fighters. Up to the present, however, only the great powers have had the means to develop such aircraft and to put them into production. There are three ways open to a small country wishing to acquire flying equipment of this sort ; and one is more wearisome than the other : purchasing foreign aircraft, building foreign aircraft under licence, or developing her own constructions. The first way costs a lot of money, the second more money and lots of work, the third still more money, still more work and, additionally, creative powers. Long-term planning, however, shows the result to be worth the expense.

Thus it can be seen that ten years of work have enabled Sweden to build up an industry allowing her to tread this third, proud path in order to arm in the air. And today this industry makes it possible for her to jump from conventionally-powered to jet-propelled fighters.

It is already two and a half years ago since *Svenska Aeroplan A.B.,* of Linköping and Trollhättan, started on the development of a modern jet fighter, the SAAB 1001, which has been designated *J 29* by the Air Force. The project was worked out by Mr. Lars Brising and completed by wind-tunnel investigations in the aeronautical testing laboratories at Ulvsunda ; further flow studies were carried out with the J 29 wing installed on a SAAB "Safir" personal aircraft. The new aircraft is now complete and is slated to begin flight tests this summer. Air Force production is likely to begin before the end of the year.

The J 29 is mostly manufactured from a new Swedish light alloy which is said to be far superior in strength to the usual duralumin. The mid-set wing is swept back and, towards the tips, features slats which open automatically at low speeds. In order to avoid cut-outs in the wing panels, the nose-wheel undercarriage is made retractable into the fuselage.

Power plant is a de Havilland "Ghost" of 5,000 lbs. static thrust, which is to be built under licence in Sweden. The air intake is in the nose and the short propulsion nozzle beneath the fuselage ; the tail is swept up in order to keep the empennage outside the efflux range. The cockpit is pressurised and equipped with a pilot-ejector seat ; the plastic canopy is jettisonable.

The new fighter represents a milestone in the activities of the young Swedish aircraft industry. If its performance conforms to expectations—mention is made of a maximum speed of about 650 m.p.h.—it will in no way lag behind the best products of the mightier air powers.

Advertising in 1900

Aeronautical "Cheese Cake"

"Old Look" Publicity for "New Look" Planes

At an all-plant art exhibition last year, the "cheese cake" section got no more than a glance from employees of Northrop Aircraft, Inc. While the "leg art" drawings bore a truly professional touch, first and second prizes went to a landscape and a street scene.

Yet "cheese cake" persists strongly . . . not only in aviation publicity, but in almost every field of U.S. advertising . . . from dainty lingerie to diesel locomotives.

Undeniably, Northrop Aircrafters showed good taste in their preference for other things than scantily-clad, pretty girls. But the disquietening fact remains, nevertheless, that bad taste is a popular flavour in New World advertising. It's all right if the subjects are such articles as beach apparel, but when morticians start using these tactics—as one did not so long ago—you must admit that it's carrying matters a bit far.

To get back to our subject, however, why is it that airmindedness is giving way to "bare-mindedness" in the U.S.A. ? It is not that we wish to appear prudish. Personally, we readily admit to the greatest admiration for pretty girls, but in their proper places : on country picnics, fine ; at beach parties, delightful ; if we visited a cabaret and found no girls there, we would certainly complain most energetically. But what we do grouse about is that they have no business messing around with superchargers, piston rings, exhaust manifolds, and the like. It somehow deprives them of their grace and charm when—nearly bare to the skin—they are shown amidst oily engines and greasy gadgets in general.

Or is the objective perhaps to lend grace and charm to the greasy commodities by associating them with dainty femininities ? Beauty's triumph over the Beast ?

What is sure, however, is that sex appeal is sales appeal—at least in America at present.

Will it remain so ? Frankly we have our doubts.

Here you see the presidential wardrobe on board the personal C-47 aircraft of the President of Brazil. To avoid any misapprehension, we would point out that the $30,000 worth of lavish interior, fitted by Aviation Maintenance Corp., of Van Nuys, Cal., definitely does not include Miss Zona James, AMC office worker, as standard equipment. The purpose of her intrusion upon State affairs is merely to show how easy it will be for His Excellency to hang up his clothes.

We would call the next picture "Lobster à l'Américaine," only the secondary attraction is a king crab—Pinky to you. Don't be afraid that Stewardess Arlene Lindahl of United Air Lines is about to get her pretty finger bitten off. Pinky's just 12 lbs. of dead meat. Fished in the Bering Sea, he was cooked, frozen, and flown by UAL from Seattle to Chicago where he finally wound up at the famous Pump Room of the Ambassador East Hotel.

All of which Arlene seems to think its an awful shame.

Good taste or bad taste? "It tastes like water" was the answer from both Mary Beth Wilson (left) and Kathryn Wilson Hyde when Boeing engineers asked them to sample the contents of this glass... of water! The drinking straws are of plastic material which Boeing's contemplated using for water pipes on their "Stratocruiser." Studies had shown that water carried in metal pipes often develops objectionable tastes due to chemical reactions of the many different minerals found in it throughout the world. Tasteless winners were "Tenite 2" cellulose acetate (Kathryn) and polyvinyl chloride (Mary Beth)—which leaves us none the wiser.

As for whether the picture itself is in good taste or bad taste, *confidentially*, would you prefer to see a couple of cauliflower-eared, bewhiskered riveters carrying out the test?

This new luxury reclining chair, for which we are told, "button handy to right finger-tips operates special new hydraulic mechanism which automatically reclines and locks chair in any position," is known by the alarming name of "AIRESTocrat!" However, this does not seem to disturb the beauty sleep of blonde Barbara Bates who, if you wish to know, appears in the Hal Roach Cinecolor feature comedy, "The Fabulous Joe."

Having courageously applied the "exclusive stored energy feature which lifts passenger to erect position without effort," Barbara tests the "contoured back rest which gives adequate support where needed, chiefly behind the pelvis and lower spine."

Here's a typical example of the sort of thing we just cannot condone.

There's nothing more charming than a picture of a pretty girl petting a dog, cat, rabbit, or even a guinea pig. But, we ask you . . . petting a propeller!

And when there are so many other things in the world asking nothing better than to be petted by pretty girls.

Well, it's no use complaining. Everyone can't be a two-seater Culver Model V sports plane.

And what's a Hartzell propeller got that we haven't?

Or is it that film star Margo Woode, of "Boomerang" fame, is just nuts on Navions? We only thought she seemed to be taking the propeller to heart.

Why can't people make their minds up? And why don't captions include telephone numbers?

It certainly looks as though North American Aviation's able president, Mr. James Howard ("Dutch") Kindelberger, moves fast.

This time it is no longer Margo Woode, but Bee Schweikert, a company employee, who is entrusted with the task of upholding the "cheese cake" tradition. She has just painted (at least, the caption says she painted) the company ship number on the 1,000th Navion.

The smile, however, shouldn't fool you. One thousand Navions, each of which cost $10,000 to build and sold for $7,500, adds up to a total loss of 2.5 million dollars.

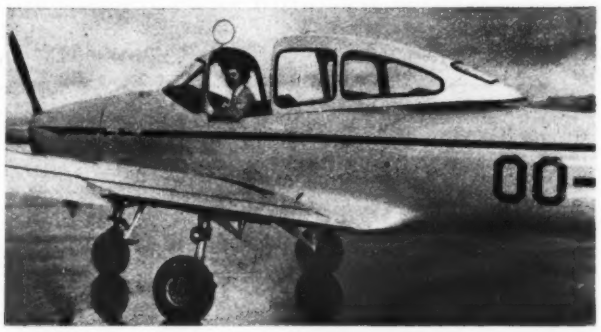
Mr. Kindelberger, by the way, has now stopped Navion production and is occupied in a more lucrative field : building bombers and fighters.

But the Navion story was by no means at an end.

For the Navion just changed its address : from North American Aviation, Inc., to Ryan Aeronautical Co. And the latter firm knew what it was doing, since the Navion, always a successful plane, is now a successful enterprise.

Our picture shows the first Ryan Navion for export. Ultimate designation is Belgium, and it already bears the "OO-EXK" foreign markings.

Pilot—yes, really the pilot—is Isble Tynon, employee of Aero-Trans ferrying service, who flew the plane from Ryan's San Diego factory to New York.



Stop me and buy one !

The engaging salesgirl, and also owner of the plane, is Betty Hughes, popular San Diego flier. What she's showing you, if you can keep your eyes on it, is the right unit of the Ryan light plane muffler. The expression in her eyes, it appears, is indicative of the lucky muffler's sturdy, light-weight construction.

If you want to be a muffler, you're suppose to muffle exhaust noise, furnish needed carburettor heat, and heat cabin air. Then Miss Hughes might have you in her plane...under the engine cowling.

Travelling light !

Very streamlined, but it is not the streamlined canopy which Hoppi-Copters, Inc., have promised for their Hoppi-Copter baby helicopter.

"Yes sir, that's my baby," this young lady might be saying as she fearlessly rests her hand on Marquardt Aircraft Company's new ram jet power plant.

A pose like this is enough to make any ram look sheepish.

"New Look" products, but the young ladies' apparel is sometimes nearly as "old lookish" as Eve. In fact, we might drop the age prefix altogether and just say "look."

And then, why hasn't anyone ever shown grandma in a plane, to prove the simplicity achieved in aeronautical design ?

What you see here, however, is not characteristic of all U. S. aviation publicity. More sober methods are luckily in the majority.

But since some firms have gone this crazy, you might ask what they'll do next. Well, there's always Picasso and Salvador Dali.

Official Bulletin of the
FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

FUTURE F.A.I. MEETINGS

Contrary to the plans made at the 1947 General Conference in Geneva, the 1948 Conference will not be held at Cleveland, Ohio, but in Paris, from September 27th to October 1st.

Despite the keen desire of all delegates of the F.A.I. to meet in America this year, this plan proved to be impossible because of the strict exchange conditions at present existing in most countries. These restrictions would have considerably reduced the number of members able to attend the Conference, thereby materially affecting the outcome of the F.A.I.'s work and decisions. For these reasons the F.A.I. has regretfully been forced to transfer the meeting place of the 41st Conference from Cleveland to Paris, though it sincerely hopes future improved conditions will allow it to accept the National Aeronautic Association's invitation in 1949.

Owing to this alteration in the F.A.I. programme, the following Commissions, which were to have met in Paris on July 6th and 7th, will meet instead on September 27th and 28th, in the same town: International Sporting Flying, Air Touring, and Model Aircraft.

On the other hand, the Commission on Gliding will meet, as arranged, at Samaden on July 27th and 28th, immediately preceding the first Congress of the International Commission for the Study of Gliding, destined to succeed ISTUS, whose agenda remains unchanged.

CUSTOMS CARNETS

After the seven years during which air touring was practically non-existent in the belligerent countries, the F.A.I. has undertaken to re-establish, as far as is possible, the system of customs carnets; so far, this has been recognised by the following sixteen countries:

Belgium, Czechoslovakia, Denmark, Egypt, Finland, France, Great Britain, Holland, Italy, Luxembourg, Norway, Roumania, Spain, Sweden, Switzerland, and Turkey.

Since the adoption of the system of customs carnets, 17,700 have been delivered by the different aero clubs, of which 3,018 since 1946, at which time private flying had been resumed to a certain extent.

If the manifold difficulties still hindering international private flying, at any rate in Europe, are taken into account, as well as the fact that only sixteen countries have reintroduced the use of this document, the number of 1,620 carnets distributed in 1947 is the best proof of the necessity of this system.

It can easily be foreseen, therefore, that under normal conditions the number of carnets demanded will considerably increase and that pre-war figures will be surpassed. Since its formation forty-three years ago, the F.A.I. has always aimed to foster, by every possible means, private flying all over the world, and particularly to persuade the authorities to lift any bans on this activity. For this reason the F.A.I. has asked ICAO to obtain recognition of the customs carnets by all member Governments who have not already done so.

HOMOLOGATION OF NEW INTERNATIONAL RECORDS

Women's Records

CLASS D (Motorless Flight), CATEGORY. I

Altitude above Point of Departure (France)
Mlle Boselli
"Meise" sailplane
Saint-Auban-sur-Durance, 6th April, 1948, *4,880 metres*

CATEGORY II (Multi-seaters)

Altitude above Point of Departure (France)
Mmes Mathé and Gaudry
"Kranich No. 32" sailplane
Saint-Auban-sur-Durance, 21st January, 1948
2,883 metres

Book Reviews

Le Grand Cirque. By Pierre Clostermann. Flammarion, Paris.

The book concerns the experiences of five French fighter pilots serving in the Royal Air Force. The author carefully kept a diary of each day's events throughout the entire campaign. He now makes his notes public as part of a thankless task of giving to the families of those who fell "the bitter consolation of at least hearing something about their children."

The story could be monotonous, since one aerial battle is inevitably the same as another. However, the characterisation of the fighter pilots, the vivid descriptions of the life they led, the hardships they faced, and the anguish they suffered at the moment of the fall of France, gives it real value.

An appendix containing details of French organisation within the R.A.F., and opinions on German fighter tactics, could prove useful to students of aerial warfare history. (French.) *J.*

Untersuchung von symmetrischen Tragflügelprofilen. By F.K. Feldmann, D.Sc. Published by A.G. Gebr. Leeman & Co., Zurich, 1948.

Long-time assistant of Professor Dr. J. Ackeret at the Aerodynamics Department of the Swiss Institute of Technology, Zurich, Dr. Feldmann groups in this pamphlet a series of investigations on symmetrical profiles in a closed wind tunnel at high subsonic velocities. The description of the methods and measuring equipment—in addition to a 3-component balance, new types of model supports were developed, which incur practically no supplementary disturbance of flow—are equally as informative as the results of the measurements, which represent a valuable contribution to knowledge of the changes in air force values when sonic speed is approached. (German with summary in English.) *Bi.*

The British Aircraft Industry, 1948. A Directory of Ordinary and Associate Members of the SBAC.

The Society of British Aircraft Constructors, Ltd., founded in 1916 to promote and protect the British aircraft industry and safeguard the interests of its member firms, is recognised as the representative body of the industry. A directory issued by the SBAC itself, therefore, cannot fail to be of value. This particular one lists 35 Ordinary Members and 339 Associate Members; the executive personnel are given in each case, as well as a brief mention, in English, French and Spanish, of the firm's past and present activities. Additionally, there is an index of 535 registered trade names.

Its 279 pages are tastefully and sturdily bound, and those who have the good fortune to receive a copy will find it a useful guide to the coming SBAC Display, scheduled to take place at Farnborough from September 7th to 12th. *Sa.*

THE MONTH IN REVIEW

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AVIATION POLITICS

● The British and French Governments are examining the possibility of pooling the operations of their airlines. Discussions are based on the assumption that other European airlines might wish to participate in the plan.

● Baron Francis Aungier Pakenham succeeded Lord Nathan as Minister of Civil Aviation on May 31st.

● A record peacetime Army-Air Force Appropriations Bill, providing $6,509,939 for the two Services, for the 1949 fiscal year beginning July 1st, 1948, was passed by the House of U.S. Representatives by a 346-2 vote on June 2nd and sent to the Senate. Of the total, $891,736,000 is earmarked for the Air Force, permitting it to increase its strength from 364,500 to 444,500 men, whilst the Army would get $5,618,203,000, enough for an increase from 542,000 to 790,000 men. The Air Force Appropriation does not include funds for aircraft, the purchase of which is dealt with separately.

● U.S. military supplies worth $59,995,000 will shortly be shipped to Persia. Shipments will include fighters, cargo aircraft, artillery, etc.

● AIR AGREEMENTS have been concluded between: Ireland and Switzerland, on May 6th in Dublin; Pakistan and Sweden, on May 6th in Karachi; Czechoslovakia and Norway, on May 7th in Prague; Greece and Switzerland, on May 26th in Athens.

NEW AIRCRAFT

● The Percival P.50 "Prince" twin-engined feeder-line transport recently made its initial flight.

● The prototype of the Martin XP5M-1 twin-engined flying-boat recently made a successful first flight from the Glenn L. Martin factory airfield at Baltimore, Md.

Martin XP5M-1

● The Boulton Paul P.108 "Balliol" three-seater trainer prototype made its official first flight on May 17th. It will be recalled that the aircraft first flew on March 24th, when it was damaged in a slight mishap. The aircraft, powered with an Amstrong Siddeley "Mamba" airscrew-turbine, was piloted by S/Ldr. Price Owen, Armstrong Siddeley Chief Test Pilot, and remained in the air for half an hour.

● Consolidated Vultee Aircraft Corp. is building a high-performance flying-boat, designated XP5Y-1, under a U.S. Navy contract. Powered with four Allison airscrew-turbines, the prototype of the new flying-boat, the largest ever built by Convair, should be ready for flight tests at the beginning of 1949. It is designed for long-range search missions, rescue operations and anti-submarine patrols.

● S.A.Italiane Ernesto Breda is studying the possibility of building a float version of its BZ 308 four-engined airliner, which would be known as the Breda-Zappata BZ 408.

● Of the SNCA du Centre NC 850 "Club" two-seater light aircraft, there is now an NC 853 version as well as the NC 851 and NC 852 versions. The new model can likewise be used for training, and the prototype is now being flight tested. It is planned to build a series of forty aircraft of this type.

NC 853 "Club"

● The Bristol Aeroplane Co., Ltd., is developing a twin-engined helicopter designated Bristol 173. It will feature two rotors in tandem and power will be supplied by two Alvis "Leonides" nine-cylinder radials of 505 H.P. for take-off. Gross weight is to be 11,000 lbs.

● Canadair Ltd. has a freight version of the Canadair DC-4M airliner in an advanced stage of development. Designated Canadair C-4F2, the new model, like the DC-4M2, has a pressurised cabin and is powered with four Rolls-Royce "Merlin 624" liquid-cooled twelve cylinder in-line engines developing 1,760 H.P. each for take-off.

POWER PLANTS

● The Aircraft Gas Turbine Division of General Electric Co. has been authorised by the USAF to disclose preliminary details of the General Electric TG-90 gas-turbine engine (USAF designation, J-47; production model, J-47A). The engine is a development of the TG-80 (J-35). Main dimensions and weight are practically unchanged, but the TG-90 produces about 25 per cent. more thrust than its predecessor, static thrust amounting to about 5,000 lbs. Additional design requirements are expected to increase this figure to 6,000 lbs. in the near future. The prototype was accepted by the USAF last Autumn, since when the model has been in production. Among other aircraft, the TG-190 will power the production version of the North American P-86A swept-wing fighter.

General Electric TG-190 (J-47)

● Wright Aeronautical Corp. has now made initial flight tests with its Wright XT-35 "Typhoon" airscrew-turbine, following the conclusion of static tests. Flight tests were carried out with the XT-35 installed in the nose of a modified B-17.

INDUSTRY

● An increase in the permissible all-up weight of the Lockheed 749 "Constellation" from 102,000 lbs. to 105,000 lbs. without any change to power plant or airscrews, has been announced by the manufacturers. At the same time, the permissible landing weight has been stepped up from 85,400 lbs. to 87,500 lbs. The improvement was made possible by minor structural modifications to the inner wing and landing gear, which increased the empty weight by only 309 lbs. The new feature will become standard on all "Constellations" due for delivery after Spring of 1949, and aircraft already in service can easily be modified by the airline companies in their own shops.

● Grumman Aircraft Engineering Corp. has received a U.S. Navy contract for 100 Grumman XF9F-2 "Panther" jet fighters, and further large orders are expected to follow.

● Consolidated Vultee Aircraft Corporation, of San Diego, Cal., celebrated its twenty-fifth anniversary on May 29th.

● The SNCA du Sud-Ouest SO 7050 two-seater personal aircraft has successfully concluded its type certification tests. Though the prototype is powered with a Mathis 4 G 60 air-cooled flat-four of 75 H.P., a tricycle-undercarriage version is being prepared for the installation of a new 90-H.P. Mathis engine now under development.

● Norsk Flyindustri A/S of Oslo-Fornebu, the Norwegian aircraft firm headed by Birger Hönningstad, is building a ten-to-fourteen seater twin-engined amphibian known as the "Finnmark."

RESEARCH

● The Arsenal S-20, an experimental guided missile, is being tested at Villacoublay. The S-20 is slung under the fuselage of a LeO 45 twin-engined bomber, and carried to a prescribed altitude before being released. All control equipment is carried aboard the LeO 45 mother aircraft.

INDUSTRIAL PERSONALITIES

● Mr. LaMotte T. Cohu, until recently President of Trans World Airline, has joined Consolidated Vultee Aircraft Corp. and replaced Mr. Harry Woodhead as President.

● Henri Potez, the well-known French industrialist, is now Chairman of SNECMA (Société Nationale d'Etudes et de Constructions de Moteurs d'Aviation), and Jacques Maillet, former Director of Production at the Air Ministry, has been appointed Managing Director of SNECMA.

● Jesus Rubio Paz and Cesar Gomez Lucia, Managing Director and General Managing of the Iberia airline, have been awarded the Grand Cross of Merit through a special decree issued by the Cabinet Council. Mr. Paz is at present conducting negotiations in the U.S.A. for the purchase of new flying equipment.

INTERNATIONAL ORGANISATIONS

● The Fédération Internationale des Transporteurs Aériens Privés (FITAP), formed November 21st, 1946, has been recognised by ICAO as an organisation equal in status to IATA.

* Excerpts from Nos. 1464-1476 (May 8th to June 4th, 1948) of "Interavia, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in three language editions, English, French and German.

● The International Air Transport Association announces that approach and landing procedures at the principal European airports have been standardised in recommendations elaborated by IATA Committees. The unified procedures, which are specially designed to avoid misunderstandings in communications between air crews and ground personnel, are to be applied to the airports of London, Paris, Prague, Brussels and Shannon.

AIR TRANSPORTATION

● EUROPE : An important change in British airline procurement policy was foreshadowed by Sir Miles Thomas, Deputy Chairman of BOAC, who indicated recently that dollars would be made available for the purchase of American airliners by the British airline corporations.

● British European Airways has elaborated a project allowing private air operators to run scheduled feeder services in Great Britain. To comply with the Civil Aviation Act of 1946, the companies will be classed as "associates" of BEAC.

● The Bill providing for the establishment of Compagnie Nationale Air-France, amended and approved by the Council of the Republic, has now been passed by the National Assembly. Share capital is to be held 70 per cent. by the Government, 15 per cent. by public and 15 per cent. by private organisations. An amendment compelling Air France to "fly French" was rejected.

● Avio Linee Italiane, the airline belonging to the Fiat group, inaugurated its Rome—Zurich service on June 14th. An intermediate stop is made at Milan. By the end of April, ALI had received two of its six Fiat G.212 three-engined airliners.

● A. B. Aerotransport's recently-purchased ten SAAB-90 "Scandia" airliners will be used to replace the company's fleet of 19 Douglas DC-3's.

● Scandinavian Airlines System will use ten of its seventeen newly-acquired Douglas DC-6 airliners on the Atlantic run, and at least three on European services. The other four are to be sold if an opportunity arises.

● All tariffs for Hungarian domestic routes were reduced by 20 per cent. on May 1st by decree of Transport Minister Ernö Gerö.

● Summer schedules recently introduced by the Soviet airlines establish a large number of new routes, most important of which is a regular passenger and freight service over the 4,780-mile Moscow—Vladivostock route across Siberia.

● ATLANTIC : According to a CAB analysis of trans-Atlantic passenger traffic to and from New York for the period July-December, 1947, a total of 3,104 scheduled passenger flights in both directions were made by the three U.S. certificated carriers (AOA, PAA and TWA) against 1,312 flights by the five foreign scheduled operators (Air France, BOAC, KLM, Sabena and SAS). U.S. carriers transported 71.2 per cent. of the total passenger traffic (81,305 passengers) whilst the foreign operators carried 28.8 per cent. (32,823 passengers).

● North Atlantic airline companies carried 162,000 passengers in both directions during 1947. Of these, 48,000 crossed the Atlantic in the first six months of 1947, about 114,000 in the second half of the year. In the first half-year the American carriers, PAA, AOA and TWA, transported 75.4 per cent. of all passengers, and in the second half only 71.2 per cent. This shows an increase in the number of passengers carried by European airlines. Scandinavian airline circles expect that about 200,000 passengers will cross the Atlantic in 1948.

● American Overseas Airlines increased its twenty trans-Atlantic round flights to 22 weekly on May 15th.

● Trans World Airline plans to intensify its New York—Madrid service to one round flight daily.

● Aerovias Guest, the Mexican airline, is now operating two round flights weekly between Mexico City and Madrid.

● With the introduction of the Douglas DC-6, KLM Royal Dutch Airlines proposes to cut travelling time on the South Atlantic route by a full day, as from June 6th.

● The Anglo-Italian Alitalia started regular services on its Rome—Rio de Janeiro—Buenos Aires route on May 26th, using Avro "Lancastrians."

● The British Cabinet is considering ordering ten Saunders-Roe SR/45 giant flying-boats for use on British routes to South America.

● Panair do Brasil, Brazilian associate of PAA, is operating its South Atlantic service to Paris, London, Rome and Istanbul from Buenos Aires instead of Rio de Janeiro, under a provisional agreement with the Argentine Government.

● The U.S. Air Force is leasing a total of 100 Curtiss C-46 "Commando" twin-engined cargo transports to 17 U.S. air freight carriers at $300 per aircraft. The machines form part of about 500 C-46's the USAF has in storage.

● American Airlines has now received seventeen of its "Convair-Liners" and all of the 75 aircraft ordered should be delivered by early 1949. AA introduced "Convair-Liners" on scheduled passenger services on June 1st, following the completion of a shake-down period with the aircraft operating freight services.

● Pan American Grace Airways (Panagra) has received the Annual Aviation Award certificate of the Inter-American Safety Council for the fourth consecutive year. In 1947 Panagra operated 112,367,000 passenger-miles and 6,830,039 aircraft-miles over a 8,878-mile route network, without any accident to passengers or crew.

● INTER-CONTINENTAL TRAFFIC : Pan American World Airways has been offering 65 different round-the-world itineraries all at the basic rate of $1,700 since May 17th.

● The Chilian licence for KLM Royal Dutch Airlines not only provides for the extension of the line's South American service to Santiago, but also for a connection with an intermediate landing in Peru, from Curacao, headquarters of KLM's West Indies Division and terminus for its north Atlantic service via New York. On May 19th KLM introduced Douglas DC-6 airliners on its Amsterdam—Johannesburg route.

● Air France plans to inaugurate a service from France to South Africa shortly. The line has already started a new high-speed Paris—Rome—Athens—Istanbul service, which is operated weekly and connects with the New York—Paris service.

● Ceskoslovenske Aerolinie, the Czechoslovak national carrier, opened a Prague—Rome—Athens—Beirut service on May 26th. A projected service to the Far East will probably be operated right through to Shanghai upon its inauguration.

● British Overseas Airways Corp. has purchased from Aerlinte Eireann five Lockheed L-749 "Constellations" at a price of £315,000 each, which is considerably more than the dollar price of new L-749 aircraft. These will be used on the London—Sydney run and the flying-boat service to Australia will be abandoned. The eighteen Short "Solent" flying-boats ordered for the Australian and Far East routes will be assigned to the recently-opened London—Johannesburg route.

● Trans-Australia Airlines expects to have its fleet of five "Convair-Liners" flying passenger services on Australian inter-capital routes (except to Perth) by mid-September. Freight carrying flights will be made beforehand in order to familiarise crews with the new aircraft.

● AIRPORTS : New York International Airport Idlewild is to be opened on July 1st, a month before its formal dedication. To begin with, three of the seven runways will be opened to service.

● Two new civil airports may be constructed in Alaska. One airport, costing $8,000,000, will be at Anchorage, and the other, costing $5,000,000, at Fairbanks. The plan is to divert civil air traffic from the USAF bases of Elmendorf and Ladd Field.

● A large airport near Catania, Sicily, is now under construction.

● The airfield of Minsk, Byelo-Russian capital, is to be turned into an international airport within the scope of the Russian five-year plan for aeronautics. Expansion work started on the airport shortly after the city's liberation is nearing completion.

SERVICE AVIATION

● The Portuguese Government is constructing the "largest naval air base in Europe" at Montijo, near Lisbon.

● The first trans-ocean formation flight by jet aircraft will be made early in July when a flight of six R.A.F. Fighter Command de Havilland "Vampire" fighters will fly from England to Canada and the United States.

● Final plans for the U.S. Navy's projected 65,000-ton aircraft carrier, which is expected to take four years to build, should be completed by the beginning of next year. Expected to cost $105,000,000, it will be a flush decker with a waterline length of 1,030 feet, and should allow B-29's and B-50's to take off (but not to land).

● The U.S. Air Force has withdrawn 325 transport aircraft which it had put up for surplus sale. The machines are being held back for possible further use by the Air Force.

● The United States Authorities have built a chain of airfields in Japan since the end of the war. All are suitable for operation by B-29's or larger bombers.

MILITARY PERSONALITIES

● Major-General Muir Stephen Fairchild has been nominated Vice-Chief of Staff of the USAF by President Truman. He is replaced as Commandant of the USAF's Air University by Major-General Robert W. Harper, who was Commanding General of Air Transport Command until the latter organisation was dissolved on June 1st.

PRIVATE FLYING

● A new 2,000-km. international closed circuit record of 720 km/h. (448 m.p.h.), was established on May 22nd with a surplus North American P-51 "Mustang" fighter by Jacqueline Cochran, the famous American woman pilot. The flight was made over a course from Palm Springs, Cal., to Santa Fé, New Mex.

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3 THOUSAND MILLION PASSENGER MILES

TRIED & PROVEN

Yes, the Lockheed Constellation has completed three *thousand million* passenger miles of dependable service.

No other high-speed transport has even approached this mark. No other high-altitude transport is so thoroughly tried and proven!

That's one of the many reasons why survey after survey shows that airline travellers prefer the Lockheed Constellation to any other type of equipment.

This passenger preference is reflected, too, in the fact that more global airlines fly the Constellation than any other transport of its class.

In order to maintain supremacy for today's finest transport, Lockheed's engineering laboratories conduct a continuing development program in behalf of the Constellation. Thus, every Constellation in service may keep abreast of the ones most recently produced.

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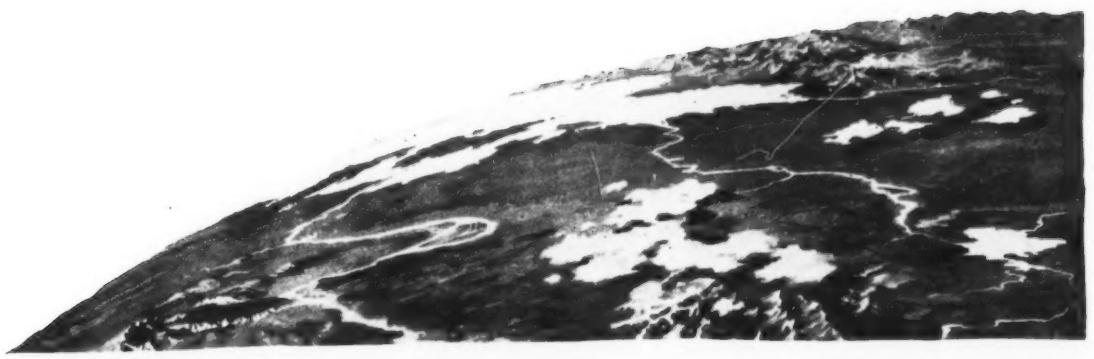
LOCKHEED CONSTELLATION

Look to Lockheed for Leadership

LOCKHEED AIRCRAFT CORP.
BURBANK, CALIF.



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